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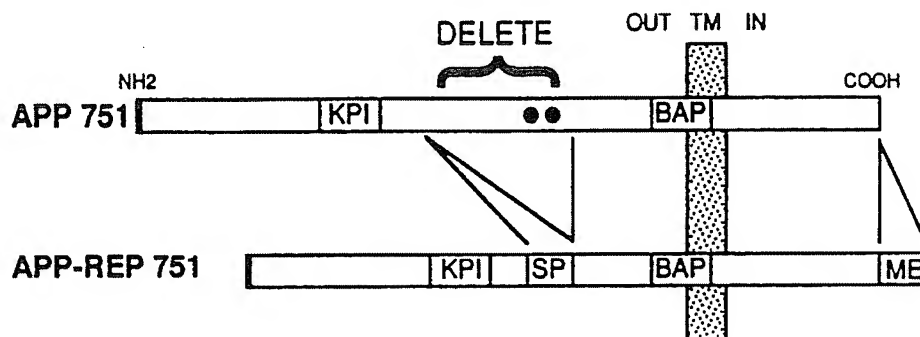
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D-80331 München (DE)(54) **Novel amyloid precursor proteins and methods of using same.**

(57) This invention provides novel nucleic acid molecules which encode amyloid precursor mutins and the polypeptides encoded therefrom. Also provided are host vector systems useful for the recombinant production of the recombinant polypeptides in procaryotic and eucaryotic systems. Cells comprising the host vector systems of this invention as well as methods of recombinantly producing these polypeptides are provided by this invention. Further provided is a method to detect the recombinant polypeptides of this invention.

Figure 1.

BACKGROUND OF THE INVENTION

Throughout this application various references are referred to within parentheses. Disclosures of these publications in their entirety are hereby incorporated by reference into this application to more fully describe the state of the art to which this invention pertains. Full bibliographic citations for these references may be found at the end of this application, immediately preceding the claims.

Abnormal accumulation of extracellular amyloid in plaques and cerebrovascular deposits are characteristic in the brains of individuals suffering from Alzheimer's disease (AD) and Down's Syndrome (Glenner and Wong, BBRC, 120:885-890, 1984; Glenner & Wong, BBRC, 120:1131-1153, 1984). The amyloid deposited in these lesions, referred to as beta amyloid peptide (BAP), is a poorly soluble, self-aggregating, 39-42 amino acid (aa) protein which is derived via proteolytic cleavage from a larger amyloid precursor protein (APP) (Kang *et al.*, Nature 325:733-736, 1987) BAP also is thought to be neurotoxic (Yankner *et al.*, Science 245:417-420, 1990). APP is expressed as an integral transmembrane protein (Dyrks *et al.*, EMBO J., 7:949-957, 1989) and is normally proteolytically cleaved by "secretase" (Sisodia *et al.*, Science, 248:492-495, 1990; Esch *et al.*, Science, 248:1122-1124) between BAP-16K (lysine) and - 17L (leucine). Cleavage at this site therefore precludes amyloidogenesis (Palmert *et al.*, BBRC, 156:432-437, 1988) and results in release of the amino-terminal APP fragment which is secreted into tissue culture medium (Sisodia *et al.*, *ibid*, Esch, *et al.*, *ibid*). Three major isoforms of APP (APP-695, APP-751 and APP-770 amino acids) are derived by alternative splicing (Ponte, *et al.*, Nature 331:525-527, 1988; Kitaguchi *et al.*, Nature 331:530-532, 1988; and Tanzi, *et al.*, Nature 331:528-530, 1988), are expressed as integral transmembrane proteins (Kang *et al.*, Nature 325:733-736, 1987; Dyrks *et al.*, EMBO J. 7:949-957, 1988).

Even though both APP-770 and -751 isoforms contain a protease inhibitor domain, it is the secreted portion of APP-751 (also known as Protease Nexin II (Van Nostrand *et al.*, Science, 248:745-748, 1990) which is thought to be involved in cell adhesion (Schubert *et al.*, Neuron, 3:689-694, 1989), remodeling during development, coagulation (Smith *et al.*, Science, 248:1126-1128, 1990) and wound repair.

Although the mechanisms underlying abnormal proteolytic processes which result in BAP extraction from APP are poorly understood, it is thought to be central to the pathogenesis (Selkoe, Neuron, 6:487-498, 1991; Isiura, J. Neurochem. 56:363-369, 1991) and memory loss (Flood, *et al.*, Proc. Natl. Acad. Sci. 88:3363-3366, 1991) associated with Alzheimer's Disease.

Based on the observations that (a) amyloid plaques develop in AD brains, (b) a major component of plaques is BAP, (c) BAP is generated by proteolytic cleavage of APP protein, (d) mRNA levels of specific APP isoforms increase in AD suggesting that more APP protein is expressed, (e) APP point mutations which are thought to possibly alter normal processing have been identified in Familial AD (FAD) and "Dutch" disease, (f) injection of BAP into the brains of rodents both form lesions reminiscent of plaque pathology and result in memory deficits, and (g) the detection of plaque-like amyloid deposits in the brains of transgenic mice expressing human APP, it is important to understand how APP is processed to generate BAP.

SUMMARY OF THE INVENTION

This invention provides novel nucleic acid molecules which encode amyloid precursor mutins and the polypeptides encoded therefrom. Also provided are host vector systems useful for the recombinant production of the recombinant polypeptides in procaryotic and eucaryotic systems. Cells comprising the host vector systems of this invention as well as methods of recombinantly producing these polypeptides are provided by this invention. Further provided is a method to detect the recombinant polypeptides of this invention.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1: Schematic representation of APP-REP 751. APP-REP 751 represents a cleavable APP substrate system which contains target sequences of BAP including normal flanking regions (not to scale). The APP-REP protein is marked with a 276 amino acid deletion (corresponding to APP-751 beginning at XhoI through to and including the glycine codon at 15 amino acid residues N-terminal to BAP) and the insertion of sequences encoding N- and C- terminal reporter epitopes. Substrate P (SP) reporter epitope (RPKPQQFFGLM) is inserted at the XhoI site. Met-enkephaline (ME) reporter epitope (YGGFM) is inserted at the C-terminus of APP. The resulting construct encodes 492 amino acids (see Figure 2).

Figure 2: Schematic representation depicting the construction of APP-REP from APP-751 cDNA. Partial representing N- and C-terminal regions of APP-REP were cloned separately as illustrated below. The N-

terminal partial was constructed by ligating sequences encoding substance P (SP) to an N-terminal fragment of APP cDNA. The C-terminal partial was constructed by PCR amplification using the corresponding portion of APP cDNA to introduce novel ends including the Met-enkephalin (ME) reporter epitope. A functional APP-REP 751 clone was obtained by subcloning the partials as indicated. EcoRI (E), XhoI (X), HindIII (H), BamHI (B), SalI (S), XbaI (Xb).

Figure 3: Epitope mapping of APP-REP 751 expressed in COS-1 cells. Immunoprecipitation analysis of cell lysate and conditioned medium using the SP (anti-N-terminal substance P reporter) and M3 (anti-C-terminal APP) antisera. Lanes 1 and 2, cell lysate immunoprecipitated with SP and M3 antisera, respectively; lanes 3 and 4, conditioned medium immunoprecipitated with M3 and SP antisera, respectively; lanes 5 and 6, conditioned medium of control cells transfected with vector DNA immunoprecipitated with SP and M3 antisera, respectively; lane M, molecular weight markers.

Figure 4: Pulse-chase analysis of APP-REP 751. Immunoprecipitation of cell lysate (A) and CM (B). COS-1 cells were pulsed with [³⁵S]-methionine for 15 minutes and chased using cold methionine for 0, 0.5, 1, 1.5, 2 and 4 hours (lanes 1 to 6). Lanes 7, 8 and 9 are chase intervals of 0, 1 and 2 hour for control cells transfected with vector DNA. Lane M, molecular weight markers.

Figure 5: Epitope mapping and comparative expression of APP-REP 751, BAP_{E22Q} and BAP_{Δ11-28}. A, Schematic representation of relevant BAP (boxed) and flanking amino acid sequences of APP-REP 751, BAP_{E22Q} and BAP_{Δ11-28} juxtaposed against the putative transmembrane domain (shadowed). B-F, Immunoprecipitation analysis with antibodies recognizing indicated substance P (SP), KPI domain (KPI), C-terminal APP (M3) or Met-enkephalin (ME) epitopes; Lane M, molecular weight marker. B, Conditioned medium obtained from COS-1 cells expressing APP-REP 751 (lane 3), BAP_{E22Q} (lanes 4, 6 and 8), BAP_{Δ11-28} (lanes 5, 7 and 9) or control cells with (lane 2) or without (lane 1) transfection with vector DNA. C, Cell lysates obtained from COS-1 cells expressing APP-REP BAP_{E22Q} (lanes 1, 4 and 7), BAP_{Δ11-28} (lanes 2, 5 and 8) and control cells transfected with vector DNA (lanes 3, 6 and 9). D, Accumulation of secreted APP-REP 751 fragments in the conditioned medium obtained from COS-1 cells expressing APP-REP 751 (lanes 2 and 6), BAP_{E22Q} (lanes 3 and 8), BAP_{Δ11-28} (lanes 4 and 7), or control cells transfected with vector DNA (lanes 1 and 5), were pulsed with [³⁵S]-methionine and chased for 45 (lanes 1-4) or 90 (lanes 5-8) minutes with cold methionine. E, Accumulation of secreted APP-REP fragments in the conditioned medium obtained from stable (Chinese hamster ovary cells; lanes 1-4) and transient (COS-1 cells; lanes 5 and 6) expression of APP-REP 751 (lanes 2 and 5), BAP_{Δ11-28} (lanes 3 and 6), BAP_{E22Q} (lane 4), or control cells transfected with vector DNA (lane 1).

Figure 6: Peptide mapping and sequencing of fragments secreted into the conditioned medium obtained from Chinese hamster ovary cells stably expressing APP-REP 751, BAP_{E22Q} and BAP_{Δ11-28}. A, Schematic representation depicting the APP-REP 751 and related derivative indicating the cleavage products and relevant carboxy-terminal fragments derived from treating the secreted fragments either with BNPS-Skatole (B) or cyanogen bromide. Downward- or upward-facing arrows represent BNPS-Skatole and cyanogen bromide cleavage sites, respectively. Amino acid lengths of relevant fragments for mapping or sequencing are given. B, BNPS-Skatole treatment of fragments secreted into the conditioned medium obtained from CHO cells stably expressing APP-REP 751 or BAP_{Δ11-28}. Mixture of conditioned medium containing APP-REP and BAP_{Δ11-28} (lane 1), or BAP_{Δ11-28} (lane 2) and APP-REP 751 (lane 3) alone.

Figure 7: Nucleotide and amino acid sequence of the APP-REP 751 protein.

Figure 8: Nucleotide and amino acid sequence of APP 770 which also is available from the Genebank data base under accession number Y00264.

DETAILED DESCRIPTION OF THE INVENTION

This invention provides a nucleic acid molecule encoding an amyloid precursor mutin, wherein the nucleic acid molecule comprises, from the 5' end to the 3' end, a nucleic acid sequence encoding a marker and a nucleic acid sequence encoding the amino terminus of APP up to but not including the sequences that encode BAP. These nucleic acid molecules may include, but are not limited to the nucleic acid molecules selected from the group consisting of pCLL983, pCLL935, pCLL934 and pCLL913.

This invention also provides a nucleic acid molecule encoding an amyloid precursor mutin, wherein the nucleic acid molecule comprises, from the 5' end to the 3' end a nucleic acid sequence encoding BAP and a nucleic acid sequence encoding a marker. These nucleic acid molecules may include, but are not limited to the nucleic acid molecules selected from the group consisting of pCLL947, pCLL914, pCLL937, pCLL949 and pCLL957.

Further provided by this invention is a nucleic acid molecule which comprises the nucleic acid molecules defined hereinabove to each other. Method of ligating are well known to those of skill in the art.

These nucleic acid molecules may include, but are not limited to the nucleic acid molecules selected from the group consisting of pCLL618, pCLL619, pCLL620, pCLL600, pCLL964, pCLL962, pCLL989, pCLL987, pCLL990, pCLL988, pCLL601, pCLL602, pCLL603, pCLL604, pCLL605, pCLL606 and pCLL607.

As used herein, the term "amyloid precursor muten" is intended to encompass an amyloid precursor protein that is mutated, i.e., it is derived from a nucleic acid molecule which has changes in its primary structure as compared to wild-type amyloid precursor protein (APP). Wild-type APP exists in three isoforms, thus, the nucleic acid molecule is changed in its primary structure for each of the three isoforms of wild-type APP. As is known to those of skill in the art, a mutation may be a substitution, deletion, or insertion of at least one nucleotide along the primary structure of the molecule. The mutations which are encompassed by this invention are the result of saturation mutagenesis in the regions of APP which are susceptible to cleavage by endoproteolytic enzymes. These mutations include deletions of nucleic acids encoding particular amino acids, substitution of nucleic acid sequences encoding one amino acid for a different amino acid and addition of nucleic acid sequences encoding additional amino acids not present in the wild type APP sequence. The term "marker" encompasses any substance capable of being detected or allowing the nucleic acid or polypeptide of this invention to be detected. Examples of markers are detectable proteins, such as enzymes or enzyme substrates and epitopes not naturally occurring in wild-type APP that are capable of forming a complex with an antibody, e.g. a polyclonal or monoclonal antibody. In the preferred embodiment of this invention, the marker is an epitope that is capable of being detected by a commercially available antibody. In one embodiment, the marker is an epitope capable of being detected by a monoclonal antibody directed to the Substance P, the Met-enkephalin or the c-myc epitope. In the most preferred embodiment of this invention, the marker is the c-myc epitopic region.

The term "BAP region" is defined as the region of APP wherein endoproteolytic cleavage will yield the amino-terminus and the carboxy-terminus of the BAP which is deposited as plaques and cerebrovascular amyloid in Alzheimer's disease brain. The function of the "BAP region" is to give rise to BAP which may function as a neurotoxic and/or neurotrophic agent in the brain and as other functionalities ascribed to BAP. The "BAP region" may also be endoproteolytically cleaved by enzymes. Such enzymes may include, but are not limited to the enzymes multicatalytic prtenase, propyl-endopeptidase, Cathepsin-B, Cathepsin-D, Cathepsin-L, Cathepsin-G or secretase. Secretase cleaves between lysine-16 (K-16) and leucine-17 (L-17) where full length BAP comprises the amino acid sequence DAEFRHDSGYEVHHQKLFFFAEDVGSNK-GAIIGLMVGGVVIA. Thus, for the purposes of this invention, the preferred embodiment is a cDNA which encodes an RNA which is translated into a protein which is the substrate for endoproteolytic activities which generate BAP.

In addition, for the purposes of this invention, the nucleic acid molecule may be DNA, cDNA or RNA. However, in the most preferred embodiment of this invention, the nucleic acid is a cDNA molecule.

This invention also encompasses each of the nucleic acid molecules described hereinabove inserted into a vector so that the nucleic acid molecule may be expressed, i.e., transcribed (when the molecule is DNA) and translated into a polypeptide in both procaryotic and eucaryotic expression systems. Suitable expression vectors useful for the practice of this invention include pSVL (Pharmacia), pRCRSV (Invitrogen), pBluescript SK⁺ (Stratagene), pSL301 (Invitrogen), pUC19 (New England Biolabs). However, in the preferred embodiment of this invention, the vector pcDNA-1-neo is the expression vector for expression in eucaryotic cells. As is well known to those of skill in the art, the nucleic acid molecules of this invention may be operatively linked to a promoter of RNA transcription, as well as other regulatory sequences. As used herein, the term "operatively linked" means positioned in such a manner that the promoter will direct the transcription of RNA off of the nucleic acid molecule, An example of a promoter is the human cytomegalovirus promoter. The vectors of this invention preferably are capable of transcribing and/or translating nucleic acid *in vitro* or *in vivo*. The recombinant polypeptides produced from the expression of the nucleic acid molecules of this invention are also provided.

A host vector system for the production of the recombinant polypeptides described hereinabove and for expressing the nucleic acid molecules of the subject invention are provided. The host vector system comprises one of the vectors described hereinabove in a suitable host. For the purpose of the invention, a suitable host may include, but is not limited to a eucaryotic cell, e.g., a mammalian cell, a yeast cell or an insect cell for baculovirus expression. Suitable mammalian cells may comprise, but are not limited to Chinese hamster ovary cells (CHO cells), African green monkey kidney COS-1 cells, and ATCC HTB14 (American Type Tissue Culture). Most preferably, the cell lines CRL 1650 and CRL 1793 are used. Each of these are available from the American Type Culture Collection (ATCC) 12301 Parklawn Drive, Rockville, Maryland U.S.A. 20852. Suitable procaryotic cell may include, but are not limited to bacteria cells, HB101 (Invitrogen), MC1061/P3 (Invitrogen), CJ236 (Invitrogen) and JM109 (Invitrogen). Accordingly, the procaryotic or eucaryotic cell comprising the vector system of this invention is further provided by this

invention.

As is known to those of skill in the art, recombinant DNA technology involves insertion of specific DNA sequences into a DNA vehicle (vector) to form a recombinant DNA molecule which is capable of being replicated in a host cell. Generally, but not necessarily, the inserted DNA sequence is foreign to the recipient DNA vehicle, i.e., the inserted DNA sequence and DNA vector are derived from organisms which do not exchange genetic information in nature, or the inserted DNA sequence comprises information which may be wholly or partially artificial. Several general methods have been developed which enable construction of recombinant DNA molecules. For example, U.S. Patent No. 4,237,224 to Cohen and Boyer describes production of such recombinant plasmids using processes of cleavage of DNA with restriction enzymes and joining the DNA pieces by known method of ligation.

These recombinant plasmids are then introduced by means of transformation or transfection and replicated in unicellular cultures including procaryotic organisms and eucaryotic organisms and eucaryotic cells grown in tissue culture. Because of the general applicability of the techniques described therein, U.S. Patent No. 4,237,224 is hereby incorporated by reference into the present specification. Another method for introducing recombinant DNA molecules into unicellular organisms is described by Collins and Hohn in U.S. Patent No. 4,304,863 which is also incorporated herein by reference. This method utilized a packaging, transduction system with bacteriophage vectors (cosmids).

Nucleic acid sequences may also be inserted into viruses, for example, a vaccinia virus or a baculovirus. Such recombinant viruses may be generated, for example, by transfection of plasmids into cells infected with virus, Chakrabarti et al, (1985) Mol. Cell Biol. 5:3402-3409.

Regardless of the method used for construction, the recombinant DNA molecule is preferable compatible with the host cell, i.e., capable of being replicated in the host cell either as part of the host chromosomes or as an extrachromosomal element. The recombinant DNA molecule or recombinant virus preferable has a marker function which allows the selection of the desired recombinant DNA molecule(s) or virus, e.g., baculovirus. In addition, if all of the proper replication, transcription and translation signals are correctly arranged on the recombinant DNA molecule, the foreign gene will be properly expressed in the transformed or transfected host cells.

Different genetic signals and processing events control gene expression at different levels. For instance, DNA transcription is one level, and messenger RNA (mRNA) translation is another. Transcription of DNA is dependent upon the presence of a promoter which is a DNA sequence that directs the binding of RNA polymerase and thereby promotes RNA synthesis. The DNA sequences of eucaryotic promoter differ from those of procaryotic promoters. Furthermore, eucaryotic promoters and accompanying genetic signals may not be recognized in or may not function in a procaryotic system.

Similarly, translation of mRNA in procaryotes depends upon the presence of the proper procaryotic signals which differ from those of eucaryotes. Efficient translation of mRNA in procaryotes requires a ribosome binding site called the Shine-Dalgarno (SD) sequence on the mRNA. For a review on maximizing gene expression, see Roberts and Lauer (1979) Methods in Enzymology 68:473.

Many other factors complicate the expression of foreign genes in procaryotes even after the proper signals are inserted and appropriately positioned. One such factor is the presence of an active proteolytic system in *E. coli* and other bacteria. This protein-degrading system appears to destroy foreign proteins selectively. A tremendous utility, therefore, would be afforded by the development of a means to protect eucaryotic proteins expressed in bacteria from proteolytic degradation. One strategy is to construct hybrid genes in which the foreign sequence is ligated in phase (i.e., in the correct reading frame) with a procaryotic structural gene.

Expression of this hybrid gene results in a recombinant protein product (a protein that is a hybrid of procaryotic and foreign amino acid sequences).

Successful expression of a cloned gene requires efficient transcription of DNA, translation of the mRNA and in some instances post-translation modification of the protein. Expression vectors have been developed to increase protein production from the cloned gene. In expression vectors, the cloned gene is often placed next to a strong promoter which is controllable so that transcription can be turned on when necessary. Cells can be grown to a high density and then the promoter can be induced to increase the number of transcripts. These, if efficiently translated, will result in high yields of polypeptide. This is an especially valuable system if the foreign protein is deleterious to the host cell.

Several recombinant DNA expression systems are described below in the Experimental Procedures section for the purpose of illustration only, and these examples should not be construed to limit the scope of the present invention.

A method for producing a recombinant polypeptide described hereinabove, is also provided. This method comprises growing the host cell containing the nucleic acid of this invention and/or the host vector

system of this invention under suitable conditions, permitting production of the polypeptide and recovering the resulting recombinant polypeptide produced.

A method of detecting in a sample the presence of any of the recombinant polypeptides described hereinabove is further provided by this invention. In the preferred embodiment of this invention, the marker
 5 is an epitope directed against an antibody, the epitope of which is not present in the wild-type polypeptide or APP derivative. This method comprises obtaining a sample suspected of containing the polypeptide and contacting the sample with an antibody directed to the marker. The contacting is done under suitable conditions to favor the formation of an antibody-epitope (i.e., antigen) complex, and detecting the presence of any complex so formed. The presence of complex being a positive indication that the recombinant
 10 polypeptide is in the sample. In one embodiment of this invention, the antibody is a mouse antibody. In another embodiment of this invention, the antibody is a human antibody. In the most preferred embodiment, the mouse or human antibody is either a mouse or human monoclonal antibody.

The antibody is labeled with a detectable marker selected from the group consisting of radioisotopes, dyes, enzymes and biotin. For the purposes of this invention, suitable radioisotopes include, but are not
 15 limited to, ^{32}P , ^{35}S , ^{131}I and ^{125}I .

Suitable samples for the practice of this invention include, but are not limited to conditioned media, cell lysates and cellular organelle fractions.

The method of this invention may utilize the recombinant polypeptide for the detection of drugs or compounds that inhibit or augment the activity of proteolytic enzymes which cleave APP to generate BAP
 20 fragments. For the purposes of example only, a recombinant polypeptide which contains a Substance-P marker epitope on the amino-terminal side of BAP and a Met-enkephalin marker epitope on the carboxy-terminal side of BAP. Using commercially available RIA kits (Peninsula), one can measure the amount of amino-marker and carboxy-marker in any given sample. Since endoproteolytic activity is shown (see Figure 3) to allow the release of amino-terminal fragments of APP containing the amino-marker into the conditioned
 25 media while carboxy-terminal APP fragments containing the carboxy-marker remain associated with the cell, then RIA which measure the amount of amino-marker in the conditioned medium as a direct result of endoproteolytic cleavage activity between the marker epitopes preferable within the "BAP region". Using this RIA to the amino-marker, the effect of potential drugs designed to modify endoprotease activity can be tested comparing the level of amino-marker in untreated and endoprotease-inhibitor treated samples. If a
 30 difference in non-treated and treated samples is found, then the position of the cleavage or lack of cleavage can be verified as with the procedures used in Figures 3 to 6. Thus, the qualitative and quantitative aspects of endoproteolytic activity and its inhibition on the recombinant APP mutain is evaluated. The amino-marker also is an enzyme such as betagalactosidase which would be released into the conditioned media by the action of an appropriate endoprotease. Cell free samples of conditioned media containing the liberated
 35 enzyme converts a chromogenic substrate into the appropriately colored product (Blue for X-gal and Yellow for ONPG) which is measured spectrophotometrically. Inhibitors of the appropriate endoprotease would inhibit the release of betagalactosidase enzyme into the conditioned medium resulting in less colored product being observed.

It is a purpose of this invention to develop a cleavable APP substrate system which represents target
 40 sequences of BAP including normal flanking regions to provide recognition sequences for processing enzymes. The utilization of a common substrate for parallel strategies involving *in vitro* cleavage assays using cellular extracts *in vivo* processing assays in tissue culture or bacterial cells, or in conjunction with a selection system aimed at cloning BAP-cleaving proteases (or other relevant proteins) is preferred.

A second purpose of this invention is to develop an APP substrate which is non-cleavable by secretase
 45 in order to better detect other putative abnormal processing events which are hypothesized to potentially either compete with secretase for limited substrate, or occur at much lower frequency than secretase and whose effects may be otherwise masked by the mass action of secretase.

Third, secretase-cleavable and -noncleavable APP substrates would provide probes with which to investigate cellular posttranslational modifications to APP in an attempt to determine the potential influence
 50 on normal secretase and abnormal BAP "clipping" activities. These areas include, among others, the consideration of various known APP point mutations, contribution by different cell/tissue types (normal- or AD-specific), the Kunitz Protease Inhibitor domain present in APP-770 and -751 isoforms, APP phosphorylation and APP glycosylation.

Fourth, the ability to detect specific APP proteolytic events, either the normal secretase or the abnormal
 55 BAP-generating activities, would enable the use of strategies which use phenotypic rescue as a marker for the cloning of potentially relevant and interesting proteases in tissue culture systems.

Overview of the APP-REP Strategy

To study secretase and BAP-generating pathways, portions of APP cDNA clones are used to engineer a panel of APP-REPorter (APP-REP) plasmids to express "marked" proteins representing each of the APP isoforms (and other APP/BAP sequence alterations; see below) in cultured cells. The system utilizes the marker Substance-P (SP) and Met-Enkephalin (ME) which are strategically placed, respectively, on amino- and carboxy-terminal sides of BAP. Proteolytic cleavage of APP-REP target substrate is determined by the electrophoretic sizing of resulting proteolytic fragments and immunological detection of APP-specific and SP and ME reporter epitopes. Deletion of a large central portion of APP sequence also makes APP-REP readily distinguishable from the endogenous APP isoforms based on size. Moreover, the resolution of detecting proteolytic cleavage at different positions within the APP-REP substrate protein is enhanced by working with shorter target substrates. Approximate location of cleavage is determined initially by fragment sizing and epitope mapping; the exact cleavage site is later determined by peptide mapping of affinity/HPLC purified fragments and sequencing of peptide ends.

Plasmids also are derived from these constructs for developing similar strategies to express APP-REP protein in cell free reticulocyte transcription-translation and bacterial systems. Mutation of APP-REP secretase/BAPase cleavage site (by sequence substitution, deletion or FAD mutations) can reveal putative proteolytic activities associated with BAP formation including amino- and carboxy-BAPase activities which are predicted to result in altered product fragments lengths.

FIRST SERIES OF EXPERIMENTS

Bacterial Strains and Transformation

Transformation of commercially available frozen competent bacteria, maintenance and selection of transformants is according to the manufacturer. Strains HB101, DH5a or JM109 (Gibco-BRL) are used for the construction of APP-REP in pSK(+) (Stratagene, La Jolla, CA) and pSL 301 (Invitrogen, San Diego, CA). APP-REP is subsequently subcloned into the eucaryotic expression vector pcDNA-1-neo and amplified in MC1061/P3 (Invitrogen, San Diego, CA).

Plasmid Construction

A cassette approach is used to independently construct portions of the APP-REP plasmid (Figure 2). The N-terminal partial includes APP sequences through the Substance P (SP) epitope, while the carboxy-terminal (C-terminal) partial includes BAP (or sequence variations of BAP) through the Metenkephalin (ME) epitope (Figure 1). Plasmid encoding the N-terminal cassette (pCLL935) is constructed by ligating the EcoRI-XhoI fragment derived from APP-751 cDNA to a short synthetic XhoI-HindIII fragment encoding Substance P (amino acid 1-11). This product is then ligated into the EcoRI and HindIII sites of pSK(+). Plasmid encoding the carboxy-terminal (C-terminal) cassette (pCLL947) is constructed by cloning into the HindIII-BamHI sites of pSL301 a fragment containing BAP sequences which is amplified by polymerase chain reaction. The fragment features a novel 5'-HindIII site beginning at lysine 638 of APP-751, native BAP through APP C-terminal sequences, and a C-terminal fusion including the Metenkephalin epitope followed by a stop translation codon and a BamHI site. The resulting pSL301 HindIII-Sall fragment (including the HindIII-BamHI coding region plus BamHI-Sall polylinker sequences) is then isolated and ligated to the N-terminal cassette by subcloning into the HindIII-Sall sites of the SK(+)-based, CMV promoter driven, eukaryotic expression vector pcDNA-1-neo (pCLL601), whose polylinker is modified to accommodate the APP-REP fragment (pCLL602). Polylinker modification involves the substitution of the HindIII-XbaI fragment with a synthetic one which restores HindIII, destroys XbaI and introduces novel BamHI-XbaI-Xho-Sall sites.

Tissue Culture Lines

All cells are obtained from American Type Culture Collection and maintained according to their recommendation. They include SV40-transformed African Green monkey kidney COS-1 cells (CRL 1650) for transient expression and Chinese hamster ovary CHO-1C6 (CRL 1973) for stable expression systems.

Transfection Procedure

Cells are seeded at a density of $2-3 \times 10^5$ /100 mm dish and transfected using Lipofectin (Gibco-BRL, Grand Island, NY) when ~75% confluent. Plasmid DNA (0.5-4 mg) is diluted in 450 μ l of Opti-MEM (Gibco-BRL, Grand Island, NY), mixed with 450 μ l containing 75-100 μ l Lipofectin and the mixture incubated at room temperature for 20-30 minutes. Addition of DNA-Lipofectin mixture to cells, recovery phase and G418 selection (Gibco-BRL), when applicable, are according to the manufacturer's protocol. Cells and conditioned medium are harvested at 48-72 hours following transfection for assay of APP-REP expression.

Antisera

APP-specific antisera: anti-N-terminal APP, mouse monoclonal 22C11 (Boehringer-Mannheim Biochemicals, Indianapolis, IN) raised against a recombinant fusion protein expressing APP-695 (epitope mapped to aa 60-100); anti-KPI rabbit polyclonal, raised against recombinant protein encoded by the HinfI fragment derived from APP-770; and anti-APP C-terminal rabbit polyclonal M3, raised against synthetic APP peptides corresponding to APP-770 amino acid residues 649-671. Reporter-specific antisera: anti-substance P, rabbit polyclonal, purchased from Peninsula, Belmont, CA; and anti-Met-enkephalin, rabbit polyclonal, purchased from Cambridge, Wilmington, DE.

Preparation of Radiolabeled APP-REP and Extraction from Conditioned Medium and Cell Lysates

APP-REP proteins transiently expressed in exponentially growing adherent cells ($\sim 4 \times 10^6$) are radiolabeled by metabolic incorporation of [35 S]-methionine as follows. Cell monolayers are washed twice with prelabeling medium (methionine-free D-HEM supplemented with glutamine, sodium pyruvate, antibiotics and 1% dialyzed fetal bovine serum (Gibco-BRL) and incubated for 15 minutes to 4 hours in prelabeling medium containing 150-450 μ Ci [35 S]-methionine (Amersham, 800Ci/mmol). If chased with cold methionine, the medium is removed following the pulse, the monolayer is washed with prelabeling medium and replaced with 3 ml of the same containing 1 mM cold methionine.

The conditioned medium is recovered following radiolabeling by aspiration from plates and cell debris removed by centrifugation for 10 minutes at 4°C ($\sim 300 \times g$). Conditioned medium is immediately supplemented with protease inhibitors (pepstatin A, 50 μ g/ml; leupeptin, 50 μ g/ml; aprotinin, 10 μ g/ml; EDTA, 5 mM; PMSF, 0.25 mM) and immunoprecipitation buffer (IPB; Sisodia *et al.*, 1990) for protein analysis. Briefly, 3 ml of CM is supplemented with 0.75 ml 5X IPB (250 mM Tris, pH 6.8; 750 mM NaCl; 25 mM EDTA; 2.5% Nonidet P40; 2.5% sodium deoxycholate) and incubated for 20 minutes at 4°C prior to use.

Lysates are prepared by washing the labeled cell monolayer twice with 5 ml pre-labeling medium and directly extracting cells in plates at 4°C with 3.75 ml 1X IPB (including protease inhibitors). Cells are scraped into the buffer, incubated for 20 minutes at 4°C and lysates clarified of cellular debris by centrifugation for 20 minutes at 10,000 $\times g$.

For radioiodination of cell surface proteins, monolayers are chilled on ice, washed 3 times with 5 ml ice cold PBS and labeled at room temperature for 10 minutes following the addition of: 5 ml PBS containing 0.2 mCi Iodine-125 (NEZ-033A, New England Nuclear), 0.25 ml lactoperoxidase (1 mg/ml distilled water, Sigma), 10 μ l of hydrogen peroxide solution (freshly prepared by diluting 10 ml of 30% stock in 10 ml of PBS) added at 0, 3, 6, and 9 minutes of iodination. At 10 minutes, the supernatant is removed and cells gently washed with 10 ml of ice cold PBS (containing 10 mM NaI). Four ml of PBS is added, and CM and cell lysates are prepared as above.

Immunoprecipitation Analysis

Aliquots of radiolabeled lysate or conditioned medium representing $4-8 \times 10^5$ cells are thawed on ice, supplemented with protease inhibitors (see above), boiled for 3 minutes in 0.35% SDS and chilled on ice. Samples are preincubated on a shaker for 1.5 hours at 4°C with 2-10 μ l 2X of preimmune (or normal rabbit) serum and 2 mg Protein A-Sepharose (Sigma; prepared in 1X IPB), and insoluble immune removed by centrifugation. APP- or reporter epitope-specific antisera (0.1-10 μ l) and 2 mg Protein A-Sepharose were similarly added and incubated overnight. Specific immune complexes were precipitated, washed 4 times with 0.25 ml 1X IPB (with protease inhibitors), extracted with 20 μ l Laemmli sample buffer (Laemmli (1970) Nature 227:680-685), boiled for 3 minutes and fractionated by electrophoresis on SDS-polyacrylamide-tris-glycine (Bio-Rad Laboratories, Richmond, VA) or SDS-polyacrylamide-tris-tricine Daiichi (Integrated Separation Systems, Natick, MA) gels. Gels are then treated with Enlightening Autoradiographic Enhancer (New

England Nuclear, NEF-974) and dried in vacuo with heat and exposed to Kodak X-AR film at -70°C.

Western (Immunoblot) Analysis

5 Lysate or 10X concentrated conditioned medium (Centricon 30 microconcentrator; Amicon, Beverly, MA) representing $4\text{--}8 \times 10^5$ cells are supplemented with an equal volume of 2X Laemmli sample buffer, boiled for 2 minutes, fractionated by electrophoresis on SDS-polyacrylamide-tris-glycine (Bio-Rad, XX) or SDS-polyacrylamide-tris-tricine Daiichi (Integrated Separation Systems, Natick, MA) gels and transblotted (Semi-Phor, Hoefer Instruments, San Francisco, CA) to Immobilon-P membrane (Millipore, Bedford, MA).
 10 Membranes are pre-blocked in 10 ml 5% non-fat dry milk/PBST (PBS with 0.02% Tween-20) for 45 minutes at room temperature prior to overnight incubation at 4°C with primary antisera (in fresh pre-blocking solution). Blots are then washed, incubated with secondary antibody, washed and developed for horseradish peroxidase activity as described (ECL Luminol Kit; Amersham, Arlington Heights, IL).

15 Peptide Mapping and Determination of the Site of Proteolytic Cleavage by Peptide Sequencing

The secretase clip site is determined essentially as described (Wang et al., (1991) J. Biol. Chem. 266:16960-16964). Approximately 1×10^6 CHO cells stably expressing APP-REP are seeded in each 150 mm dish containing DMEM (complete with 200 ug/ml G418) and incubated for 36 hours. Cells are washed,
 20 preincubated for 6 hours in serum-free medium [MCDB 302 supplemented with antibiotics, L-glutamine (292 mg/l) and proline 12 mg/l (Sigma) to remove serum components, washed, and incubated for another 72 hours in fresh serum-free media.

Serum-free conditioned medium was pooled and cell debris is removed by centrifugation (10 minutes at 300xg, then 30 minutes at 100,000xg) and concentrated by acetone precipitation and fractionated by FPLC.
 25 Conditioned medium concentrate is loaded on an anion exchange column (Mono Q; source) and protein is eluted in 20 mM Tris (pH 7.4) over a 0-1M NaCl gradient. Fractions containing secreted APP are identified by immunoblotting (monoclonal antibody 22C11) and relevant samples pooled, desalted (NP-5 column; Pharmacia, Piscataway, NJ) and concentrated. Proteins are then denatured, treated with cyanogen bromide (in 10% trifluoroacetic acid) and peptides separated by high performance liquid chromatography (Vydac
 30 C₁₈ reverse-phase) attached to a FAB-MS unit. Relevant peaks derived from APP-REP 751 and APP-REP BAP₁₁₋₂₈ are identified by locating those peaks uncommon to both proteins. The C-terminal peptides derived from APP-REP BAP₁₁₋₂₈ (predicted 14 amino acid) and APP-REP 751 (predicted 17 amino acid) are sequenced (MilliGen solid phase peptide sequencer; Millipore, Burlington, MA).

35 EXPERIMENTAL RESULTS

Characterization of APP-REP Expression by Epitope Mapping

The APP-REP strategy (Figure 1) is system for the expression of marked APP proteins in tissue culture
 40 cells in order to characterize the proteolytic cleavage events. The deletion of 276 amino acid portion distinguishes the construct of this invention from endogenously expressed APP on the basis of size, and is predicted to increase the resolution of APP-REP fragments resulting from the proteolytic cleavage by secretase or other amyloidogenic, BAP-generating cleavage events. Substance P and Met-enkephalin marker epitopes strategically placed on either side of BAP enable the immunological detection of N- and C-terminal fragments, respectively, which result from proteolytic cleavage of APP-REP substrate.
 45

APP-REP protein transiently expressed in COS-1 cells has been radiolabeled by metabolic incorporation of [³⁵S]-methionine in a 60 minute pulse, immunoprecipitated with antisera, and size fractionated by gel electrophoresis as demonstrated in Figure 3. Immunoprecipitation with a panel of APP- and APP-REP-specific antisera which recognize epitopes mapping at various positions along APP-REP, reveals the
 50 presence of 2 proteins of ~63 kDa in cell lysates (including cytoplasmic and membrane associated proteins) as shown in Figure 3. The specific detection by antisera directed against the KPI domain, the carboxy-terminus of APP (M3, Figure 3A) and Met-enkephalin, as well as by the N-terminal 22C11 monoclonal in Western blot analysis (data not shown), suggests that both bands represent the full-length APP-REP protein. Although the 492 amino acid APP-REP is predicted to display a mobility of ~49-54 KdA, the larger 63 and
 55 76 kDa proteins are expected based on previous observations attributing the aberrant migration properties of APP, putatively to post-translational modification like tyrosine-sulfation, glycosylation and phosphorylation (Dyrks et al., (1988) EHSO J. 7:949-957; Weidemann et al., (1989) Cell 57:115-126.

Analysis of the conditioned medium (CM) collected from those same cells above indicates that an N-terminal fragment of APP-REP is released into the CM. Figure 3B reveals a shorter ~67 kDa fragment immunoprecipitable from CM with KPI and SP antisera (and the 22C11 monoclonal by Western analysis), but not with several C-terminal APP or ME antisera. These data are consistent with the observations (Selkoe et al., (1988) P.N.A.S. 86:6338-6342; Palmert et al., (1989 a) P.N.A.S. U.S.A. 85:7341-7345), b) indicating that APP is a substrate for the proteolytic cleavage resulting in the secretion of an N-terminal fragment into CM, and a short membrane associated C-terminal fragment.

Pulse-Chase Analysis Reveals the Precursor/Product Relationship Between Cell Associated and Secreted Derivatives of APP-REP

To show that APP-REP undergoes post-translational modification accounting for the 2 cell associated proteins, and that the N-terminal APP-REP fragment released into CM is derived from one of these precursors, radiolabeled APP-REP is with a short 15 minute pulse and collected both cell lysates and CM at various chase intervals as shown in Figure 4. Immunoprecipitation analysis reveals that APP-REP initially migrates at ~63 kDa and is rapidly "chased" up to ~76 kDa with conversion rate of less than 10-15 minutes (Figure 4A; also see Figure 5C for quantitative analysis), an observation which is consistent with the notion that APP-REP, like APP, is substrate for posttranslational modifications.

The ~76 kDa APP-REP band (cell lysate) rapidly disappears ($t^{1/2}$ ~20 minutes) (Figure 4A and 5C), followed by the appearance of a shorter ~67 kDa band in the CM (Figure 4B and 5C). The released ~67 kDa fragment accumulates rapidly and is relatively long lived ($t^{1/2}$ > 8 hours). The temporal pattern of intracellular APP-REP depletion, accumulation of a shorter ~67 kDa protein in CM, and the recognition of this protein only by antisera raised against N-terminal epitopes, is consistent with proteolytic cleavage of APP-REP which is similar to the normal, non-amyloidogenic, "secretase" activity which results in the release of an N-terminal APP fragment (Sisodia et al., (1990) Science 248:492-495).

Expression of APP-REP Derivatives Containing Altered BAP Sequences Does Not Prevent Proteolytic Cleavage

In an attempt to engineer non-cleavable substrates for secretase, APP-REP proteins are expressed (Figure 5A) either lacking the secretase "cleavage/recognition site" putatively encompassed by aa residues BAP 11-28 (BAP $_{\Delta 11-28}$ pCLL604), or representing the BAP point mutation found in patients with HCHWA-D (BAP $_{E22Q}$ pCLL603). The construct representing the BAPE22Q mutation results in secretion of an N-terminal fragment indistinguishable from the APP-REP protein (Figure 5C). Deletion of extracellular, juxtamembranous 18 aa (BAP $_{\Delta 11-28}$), however, still results in the secretion of an N-terminal APP-REP fragment into the CM (Figure 5B). A slightly faster migration of fragment derived from the deletion construct pCLL604 in comparison to that of wild-type pCLL602, is consistent with the 18 aa deletion and a corresponding loss of ~2 kDa (Figure 5C). Pulse-chase analyses (Figure 5D) indicate that expression of full-length precursor by each construct, proteolytic cleavable and the release of fragment into CM is both qualitatively and quantitatively similar to that of the wild-type APP-REP sequence. Chinese hamster ovary (CHO) cells stably expressing APP-REP display results similar to that of transiently expressing COS-1 cells (Figure 5E). Collectively, these data suggest that the cleavage in each case may be the result of similar biochemical events despite the difference in juxtamembranous sequences (Figure 5A).

Full-Length APP-REP Proteins Are Associated with Plasma Membrane Prior to Cleavage

In preliminary experiments, detection of the amino-terminal APP-REP fragment in CM and not in cell lysates, suggests that the putative secretase activity might be plasma membrane-associated. One prediction of this notion is that an N-terminal portion of APP-REP might be (partially) localized to the extracellular environment prior to cleavage. In order to test this hypothesis, CHO cells stably expressing APP-REP (pCLL602) are subjected to lactoperoxidase-catalyzed iodination to radiolabel only extracellular proteins associated with the cell surface, and CM and cell lysates were analyzed immediately following iodination or after a 10 minute incubation. Presence of the ~76 kDa APP-REP band in cell lysate should indicate that at least a portion of full-length APP-REP is poised extracellularly in association with cell membrane. Detection of both, a reduced fraction of the ~76 kDa band in the cell lysate and a corresponding increased fraction of ~67 kDa fragment in CM following the "release" incubation, would suggest that the extracellular portion of APP-REP is cleaved.

Peptide Sequencing to Determine the site of Proteolysis

Fragment secreted into serum-free media derived from CHO cells stably expressing APP-REP with wild-type or BAP 11-28 sequences has been analyzed to determine the actual site of proteolytic cleavage as shown in Figure 6. Peptide mapping by tryptophan-specific cleavage with BNPS-skatole is used to roughly determine the approximate position of cleavage in each molecule. Western blot analysis using SP antisera following BNPS-skatole treatment (Figure 6B) reveals fragments whose lengths of ~10.5 and ~9.5 kDa, corresponding to wild type and BAP₁₁₋₂₈ respectively, confirming that cleavage occurs in the C-terminal portion of the PN-2-like protein as expected (Figure 6A). To determine the actual position of cleavage, secreted fragment is partially purified, treated with cyanogen bromide and relevant C-terminal peptides derived from APP-REP wild type.

DISCUSSION

The examined the expression of a truncated form of APP-751, namely APP-REP 751 (pCLL602) is examined and its normal cleavage by secretase. Comparison of the nontransfected cells and those transfected with APP-REP 751, in both COS-1 transient and CHO stable expression systems, show the production of shorter secreted protein derived from APP-REP. Furthermore, upon a prolonged exposure of the fluorogram only one band is observed in condition medium. Epitope mapping with antibodies to N- and C-terminal domains of APP-REP and amino acid sequencing suggest post-translational cleavage at a site similar to that reported for intact APP protein and other truncated APP constructs similar to that reported for intact APP protein and other truncated APP constructs. Pulse-chase experiments reveal post-translational modifications, believed to be similar to those described for the intact APP protein, in which a single ~63 kDa product is chased up to ~76 kDa in the first 30 minutes. Appearance of the ~76 kDa cell membrane associated protein precedes the release of a ~67 kDa product into the CM. The released form, which is not observed in the cell lysate fraction, steadily accumulates in the conditioned medium well after the ~76 kDa band has begun to disappear suggesting a precursor-product relationship. These data indicate that the APP-REP protein is a good representation of the naturally occurring APP with respect to post-translational synthesis, processing, and stability in a tissue culture system.

Epitope mapping of APP-REP 751 mutants suggest that BAP_{E22Q}, as well as the BAP_{Δ11-28} deletion constructs, are initially expressed as larger proteins of predicted lengths which subsequently are cleaved to release N-terminal fragments into the CM. The pulse-chase experiments indicate the cell-associated and secreted forms accumulate with similar kinetics.

TABLE 1

Construction of APP-REP Partials

- 5 A. pSK(+) Amino-Terminal Constructs:
Cloning of APP Isoform and Reporter
Epitope (EcoRI-HindIII Fragments)

10	Plasmid <u>Name</u>	APP Isoform (<u>EcoRI-XhoI Fragment</u>)	Reporter Epitope (<u>XhoI-HindIII Fragment</u>)
	pCLL983	APP-695	Substance P*
15	pCLL935	APP-751	Substance P
	pCLL934	APP-770**	Substance P
	pCLL913	APP-770#	Substance P

Notes:

* Substance P is a peptide containing 11 residues with the amino acid sequence of RPKPQQFFGLM.

25 ** 5' untranslated sequences derived from the shorter APP-770 cDNA form.

5' untranslated sequences derived from the longer APP-751 cDNA form.

- 30 B. pSL301 Carboxy-Terminal Constructs: Cloning
of BAP-Encoding APP Reporter Epitope Fusions
(HindIII-BamHI/SalI Fragment)

35	Plasmid <u>Name</u>	Met-Enkephalin (ME) <u>Fusion at end of:</u>	<u>Name of Variation</u>
40	pCLL947	Full-Length APP	APP-BAP-APP-ME
	pCLL914	Transmembrane Domain	APP-BAP-TM-ME
	pCLL937	BAP	APP-BAP-ME

TABLE 1

Construction of APP-REP Partial

(Continued)

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C. pSL301 Carboxy-Terminal Full-Length APP-ME
 Constructs: Introduction of Mutations in BAP
(HindIII-BamHI/SalI Fragment)

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Plasmid Met-Enkephalin

<u>Name</u>	<u>Fusion at End of:</u>	<u>Name of Variation</u>
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pCLL949	E to Q substitution at	BAP22EQ
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BAP aa#22

pCLL957	G to A substitution at	BAP-vaall-28
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BTaa#10, deletion of BAP

AA#11-28 and creation of

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NdeI site

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TABLE 2
Assembly of APP-REP Full-Length Constructs
Containing Substance P and Met-Enkephalin
Reporter Epitopes and BAP or a Variation of BAP

Plasmid Name	Construct Name/Variation	Plasmid		Restriction Fragment
		(N-Terminus)	(C-Terminus)	
pCLL618	APP-REP-695	pCLL983	pCLL947	
pCLL964	APP-REP-751	pCLL935	pCLL947	
pCLL962	APP-REP-770	pCLL934	pCLL947	
pCLL619	APP-REP-695/BAP _E to Q	pCLL983	pCLL949	
pCLL989	APP-REP-751/BAP _E to Q	pCLL935	pCLL949	
pCLL987	APP-REP-770/BAP _E to Q	pCLL934	pCLL949	
pCLL620	APP-REP-695/BAP _{aa11-28}	pCLL983	pCLL957	
pCLL990	APP-REP-751/BAP _{aa11-28}	pCLL935	pCLL957	
pCLL988	APP-REP-770/BAP _{aa11-28}	pCLL934	pCLL957	

TABLE 3
Subcloning of APP-REP Full-Length Constructs
and Human Growth Hormone (hGH) into pcDNA-1-Neo[XS]

Plasmid Name	Construct Name (in pcDNA-1-neo)	Source of Insert
pCLL600	pcDNA-1-neo-hGH	p0GH*
pCLL601	pcDNA-1-neo[XS]	Synthetic Fragment**
pCLL602	APP-REP-751	pCLL964
pCLL603#	APP-REP-751/BAP _E to Q	pCLL989
pCLL604#	APP-REP-751/BAP _{aa11-28}	pCLL990
pCLL605	APP-REP-770	pCLL962
pCLL606	APP-REP-770/BAP _E to Q	pCLL987
pCLL607	APP-REP-770/BAP _{aa11-28}	pCLL988

Notes:

* The HindIII-EcoRI (blunt-ended) fragment encoding hGH sequences of p0HG (Nichols Diagnostics) was subcloned into the HindIII-EcoRI (blunt-ended) sites of pcDNA-1-neo.

** The HindIII-XbaI fragment of the pcDNA-1-neo polylinker was replaced with a synthetic fragment which destroyed the original XbaI site and introduced several unique sites (HindIII-BamHI-XbaI-XhoI-SalI).

Also created by an alternative strategy using the same pSK(+) plasmids.

TABLE 4
 "Secretase-Minus" APP-REP Constructs
 Engineered by Oligonucleotide-Directed Mutagenesis

Plasmid Name	Mutation Identity	Mutated BAP Sequence Compared to Wild Type							Percent** Secretion
pCLL602	BAP*	14	15	16	17	18	19	20	100
		CAT	CAA	AAA	TTG	GTG	TTC	TTT	
pCLL608	BAP-16KE	H	Q	K	L	V	F	F	0
		CAT	CAA	GAG	TTG	GTG	TTC	TTT	
pCLL609	BAP-16KV	H	Q	E	L	V	F	F	10-20
		CAT	CAA	GTG	TTG	GTG	TTC	TTT	
pCLL610	BAP-19FP	H	Q	V	L	V	F	F	10-20
		CAT	CAA	AAA	TTG	GTG	CCG	TTT	
		H	Q	K	L	V	P	F	

Notes:

* Wild-type BAP

* % secretion relative to wild type BAP sequence as determined by Sisodia.

TABLE 5
APP-REP Constructs Modeling APP Mutations
Associated with Diseases Involving BAP Deposition

APP "717" MUTATIONS

		// APP Transmembrane Domain /								
		// [BAP]								
		711	712	713	714	715	716	717	718	719
		[40	41	42]						
pCLL602	APP*	GTC	ATA	GCG	ACA	GTG	ATC	GTC	ATC	ACC
		V	I	A	T	V	I	V	I	T
pCLL611	717VI**	GTC	ATA	GCG	ACA	GTG	ATC	ATC	ATC	ACC
		V	I	A	T	V	I	I	I	T
pCLL612	717VG@	GTC	ATA	GCG	ACA	GTG	ATC	GGC	ATC	ACC
		V	I	A	T	V	I	G	I	T
pCLL613	717VF\$	GTC	ATA	GCG	ACA	GTG	ATC	TTC	ATC	ACC
		V	I	A	T	V	I	F	I	T'

TABLE 5 (continued)

DUTCH DISEASE				:	V (secretase clip)						
35		686	687	:	688	689	690	691	692	693	694
		[15	16	:	17	18	19	20	21	22	23]
	pCLL602 BAP*	CAA	AAA	:	TTG	GTG	TTC	TTT	GCG	GAA	GAT
40		Q	K	:	L	V	F	F	A	E	D
	pCLL603 BAP-22EQ#	CAA	AAA	:	TTG	GTG	TTC	TTT	GCA	<u>CAA</u>	GAT
45	pCLL606#	Q	K	:	L	V	F	F	A	Q	D

Notes:

APP-REP-751 and -770 derived BAP-22EQ constructs.

** Goate et al. (1991) Nature, 349:704-706; Yoshioka et al. (1991) BBRC 178:1141-1146; Naruse et al. (1991) Lancet 337:978-979.

@ Chartier-Harlin et al. (1991) Nature 353:844-846.

\$ Murrell et al. (1991) Science 254:97-99.

(2) INFORMATION FOR SEQ ID NO:27:

(i) SEQUENCE CHARACTERISTICS:

- 5 (A) LENGTH: 9 amino acids
(B) TYPE: amino acid
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

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(xi) SEQUENCE DESCRIPTION: SEQ ID NO:27:

Gln Lys Leu Val Phe Phe Ala Gln Asp
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SEQUENCE LISTING

(1) GENERAL INFORMATION:

- 5 (i) APPLICANT:
 (A) NAME: American Cyanamid Company
 (B) STREET: 1937 West Main Street
 (C) CITY: Stamford
 (D) STATE: Connecticut
 (E) COUNTRY: U.S.A.
 10 (F) POSTAL CODE (ZIP): 06904-0060
- (ii) TITLE OF INVENTION: Novel Amyloid Precursor Proteins and Methods
 of Using Same
- 15 (iii) NUMBER OF SEQUENCES: 27
- (iv) COMPUTER READABLE FORM:
 (A) MEDIUM TYPE: Floppy disk
 (B) COMPUTER: IBM PC compatible
 (C) OPERATING SYSTEM: PC-DOS/MS-DOS
 (D) SOFTWARE: PatentIn Release #1.0, Version #1.25 (EPO)
- 20 (v) CURRENT APPLICATION DATA:
 APPLICATION NUMBER: EP 93105718

(2) INFORMATION FOR SEQ ID NO:1:

- 25 (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 1721 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear
- 30 (ii) MOLECULE TYPE: peptide
- (iii) HYPOTHETICAL: NO
- (iv) ANTI-SENSE: NO
- 35 (vi) ORIGINAL SOURCE:
 (A) ORGANISM: Homo sapiens
- (ix) FEATURE:
 (A) NAME/KEY: CDS
 (B) LOCATION: 196..1671
- 40

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:1:

AAGCTTGGGG ATCCGCTCTA GAACTAGTGG ATCCCCCGGG CTGCAGGAAT TCGGGGGGGG

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	CAGCGGTAGG	CGAGAGCACG	CGGAGGAGCG	TGCGCGGGGC	CCCGGGAGAC	GGCGGCGGGT	120										
	GCGGCGCGGG	CAGAGCAAGG	ACGCGGCGGA	TCCCACTCGC	ACAGCAGCGC	ACTCGGTGCC	180										
5	CCGCGCAGGG	TCGCG	ATG	CTG	CCC	GGT	TTG	GCA	CTG	CTC	CTG	CTG	GCC	GCC	231		
			Met	Leu	Pro	Gly	Leu	Ala	Leu	Leu	Leu	Leu	Ala	Ala			
			1				5						10				
	TGG	ACG	TCT	CGG	GCG	CTG	GAG	GTA	CCC	ACT	GAT	GGT	AAT	GCT	GGC	CTG	279
	Trp	Thr	Ser	Arg	Ala	Leu	Glu	Val	Pro	Thr	Asp	Gly	Asn	Ala	Gly	Leu	
			15					20					25				
10	CTG	GCT	GAA	CCC	CAG	ATT	GCC	ATG	TTC	TGT	GGC	AGA	CTG	AAC	ATG	CAC	327
	Leu	Ala	Glu	Pro	Gln	Ile	Ala	Met	Phe	Cys	Gly	Arg	Leu	Asn	Met	His	
		30					35					40					
	ATG	AAT	GTC	CAG	AAT	GGG	AAG	TGG	GAT	TCA	GAT	CCA	TCA	GGG	ACC	AAA	375
15	Met	Asn	Val	Gln	Asn	Gly	Lys	Trp	Asp	Ser	Asp	Pro	Ser	Gly	Thr	Lys	
		45				50					55					60	
	ACC	TGC	ATT	GAT	ACC	AAG	GAA	GGC	ATC	CTG	CAG	TAT	TGC	CAA	GAA	GTC	423
	Thr	Cys	Ile	Asp	Thr	Lys	Glu	Gly	Ile	Leu	Gln	Tyr	Cys	Gln	Glu	Val	
					65					70					75		
20	TAC	CCT	GAA	CTG	CAG	ATC	ACC	AAT	GTG	GTA	GAA	GCC	AAC	CAA	CCA	GTG	471
	Tyr	Pro	Glu	Leu	Gln	Ile	Thr	Asn	Val	Val	Glu	Ala	Asn	Gln	Pro	Val	
				80					85					90			
	ACC	ATC	CAG	AAC	TGG	TGC	AAG	CGG	GGC	CGC	AAG	CAG	TGC	AAG	ACC	CAT	519
25	Thr	Ile	Gln	Asn	Trp	Cys	Lys	Arg	Gly	Arg	Lys	Gln	Cys	Lys	Thr	His	
			95					100					105				
	CCC	CAC	TTT	GTG	ATT	CCC	TAC	CGC	TGC	TTA	GTT	GGT	GAG	TTT	GTA	AGT	567
	Pro	His	Phe	Val	Ile	Pro	Tyr	Arg	Cys	Leu	Val	Gly	Glu	Phe	Val	Ser	
		110					115					120					
30	GAT	GCC	CTT	CTC	GTT	CCT	GAC	AAG	TGC	AAA	TTC	TTA	CAC	CAG	GAG	AGG	615
	Asp	Ala	Leu	Leu	Val	Pro	Asp	Lys	Cys	Lys	Phe	Leu	His	Gln	Glu	Arg	
		125				130					135					140	
	ATG	GAT	GTT	TGC	GAA	ACT	CAT	CTT	CAC	TGG	CAC	ACC	GTC	GCC	AAA	GAG	663
35	Met	Asp	Val	Cys	Glu	Thr	His	Leu	His	Trp	His	Thr	Val	Ala	Lys	Glu	
					145					150					155		
	ACA	TGC	AGT	GAG	AAG	AGT	ACC	AAC	TTG	CAT	GAC	TAC	GGC	ATG	TTG	CTG	711
	Thr	Cys	Ser	Glu	Lys	Ser	Thr	Asn	Leu	His	Asp	Tyr	Gly	Met	Leu	Leu	
				160					165					170			
40	CCC	TGC	GGA	ATT	GAC	AAG	TTC	CGA	GGG	GTA	GAG	TTT	GTG	TGT	TGC	CCA	759
	Pro	Cys	Gly	Ile	Asp	Lys	Phe	Arg	Gly	Val	Glu	Phe	Val	Cys	Cys	Pro	
			175					180					185				

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	CTG	GCT	GAA	GAA	AGT	GAC	AAT	GTG	GAT	TCT	GCT	GAT	GCG	GAG	GAG	GAT	807
	Leu	Ala	Glu	Glu	Ser	Asp	Asn	Val	Asp	Ser	Ala	Asp	Ala	Glu	Glu	Asp	
	190						195					200					
5	GAC	TCG	GAT	GTC	TGG	TGG	GGC	GGA	GCA	GAC	ACA	GAC	TAT	GCA	GAT	GGG	855
	Asp	Ser	Asp	Val	Trp	Trp	Gly	Gly	Ala	Asp	Thr	Asp	Tyr	Ala	Asp	Gly	
	205				210						215					220	
	AGT	GAA	GAG	AAA	GTA	GTA	GAA	GTA	GCA	GAG	GAG	GAA	GAA	GTG	GCT	GAG	903
	Ser	Glu	Glu	Lys	Val	Val	Glu	Val	Ala	Glu	Glu	Glu	Glu	Val	Ala	Glu	
10					225					230					235		
	GTG	GAA	GAA	GAA	GAA	GCC	GAT	GAT	GAC	GAG	GAC	GAT	GAG	GAT	GGT	GAT	951
	Val	Glu	Glu	Glu	Glu	Ala	Asp	Asp	Asp	Glu	Asp	Asp	Glu	Asp	Gly	Asp	
					240				245					250			
15	GAG	GTA	GAG	GAA	GAG	GCT	GAG	GAA	CCC	TAC	GAA	GAA	GCC	AGA	GAG	AGA	999
	Glu	Val	Glu	Glu	Glu	Ala	Glu	Glu	Pro	Tyr	Glu	Glu	Ala	Arg	Glu	Arg	
					255			260					265				
	ACC	ACC	AGC	ATT	GCC	ACC	ACC	ACC	ACC	ACC	ACC	ACA	GAG	TCT	GTG	GAA	1047
	Thr	Thr	Ser	Ile	Ala	Thr	Thr	Thr	Thr	Thr	Thr	Thr	Glu	Ser	Val	Glu	
20																	
	GAG	GTG	GTT	CGA	GAG	GTG	TGC	TCT	GAA	CAA	GCC	GAG	ACG	GGG	CCG	TGC	1095
	Glu	Val	Val	Arg	Glu	Val	Cys	Ser	Glu	Gln	Ala	Glu	Thr	Gly	Pro	Cys	
	285					290					295					300	
	CGA	GCA	ATG	ATC	TCC	CGC	TGG	TAC	TTT	GAT	GTG	ACT	GAA	GGG	AAG	TGT	1143
25	Arg	Ala	Met	Ile	Ser	Arg	Trp	Tyr	Phe	Asp	Val	Thr	Glu	Gly	Lys	Cys	
					305					310					315		
	GCC	CCA	TTC	TTT	TAC	GGC	GGA	TGT	GGC	GGC	AAC	CGG	AAC	AAC	TTT	GAC	1191
	Ala	Pro	Phe	Phe	Tyr	Gly	Gly	Cys	Gly	Gly	Asn	Arg	Asn	Asn	Phe	Asp	
30					320				325					330			
	AGA	GAA	GAG	TAC	TGC	ATG	GCC	GTG	TGT	GGG	AGC	GCC	ATT	CCT	ACA	ACA	1239
	Arg	Glu	Glu	Tyr	Cys	Met	Ala	Val	Cys	Gly	Ser	Ala	Ile	Pro	Thr	Thr	
					335			340					345				
35	GCA	GCC	AGT	ACC	CCT	GAT	GCC	GTT	GAC	AAG	TAT	CTC	GAG	CGG	CCC	AAG	1287
	Ala	Ala	Ser	Thr	Pro	Asp	Ala	Val	Asp	Lys	Tyr	Leu	Glu	Arg	Pro	Lys	
							355					360					
	CCC	CAG	CAG	TTC	TTT	GGC	CTG	ATG	GGA	AGC	TTG	ACA	AAT	ATC	AAG	ACG	1335
	Pro	Gln	Gln	Phe	Phe	Gly	Leu	Met	Gly	Ser	Leu	Thr	Asn	Ile	Lys	Thr	
40						370					375					380	
	GAG	GAG	ATC	TCT	GAA	GTG	AAG	ATG	GAT	GCA	GAA	TTC	CGA	CAT	GAC	TCA	1383
	Glu	Glu	Ile	Ser	Glu	Val	Lys	Met	Asp	Ala	Glu	Phe	Arg	His	Asp	Ser	
					385					390					395		

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GGA TAT GAA GTT CAT CAT CAA AAA TTG GTG TTC TTT GCA GAA GAT GTG 1431
 Gly Tyr Glu Val His His Gln Lys Leu Val Phe Phe Ala Glu Asp Val
 400 405 410
 5 GGT TCA AAC AAA GGT GCA ATC ATT GGA CTC ATG GTG GGC GGT GTT GTC 1479
 Gly Ser Asn Lys Gly Ala Ile Ile Gly Leu Met Val Gly Gly Val Val
 415 420 425
 ATA GCG ACA GTG ATC GTC ATC ACC TTG GTG ATG CTG AAG AAG AAA CAT 1527
 Ile Ala Thr Val Ile Val Ile Thr Leu Val Met Leu Lys Lys Lys His
 430 435 440
 10 TAC ACA TCC ATT CAT CAT GGT GTG GTG GAG GTT GAC GCC GCT GTC ACC 1575
 Tyr Thr Ser Ile His His Gly Val Val Glu Val Asp Ala Ala Val Thr
 445 450 455 460
 15 CCA GAG GAG CGC CAC CTG TCC AAG ATG CAG CAG AAC GGC TAC GAA AAT 1623
 Pro Glu Glu Arg His Leu Ser Lys Met Gln Gln Asn Gly Tyr Glu Asn
 465 470 475
 CCA ACC TAC AAG TTC TTT GAG CAG ATG CAG AAC TAT GGG GGC TTC ATG 1671
 Pro Thr Tyr Lys Phe Phe Glu Gln Met Gln Asn Tyr Gly Gly Phe Met
 480 485 490
 20 TAGGATCCAT ATATAGGGCC CGGGTTATAA TTACCTCAGG TCGACCTAGA 1721

(2) INFORMATION FOR SEQ ID NO:2:

25 (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 492 amino acids
 (B) TYPE: amino acid
 (D) TOPOLOGY: linear

30 (ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:2:

Met Leu Pro Gly Leu Ala Leu Leu Leu Leu Ala Ala Trp Thr Ser Arg
 1 5 10 15
 35 Ala Leu Glu Val Pro Thr Asp Gly Asn Ala Gly Leu Leu Ala Glu Pro
 20 25 30
 Gln Ile Ala Met Phe Cys Gly Arg Leu Asn Met His Met Asn Val Gln
 35 40 45
 40 Asn Gly Lys Trp Asp Ser Asp Pro Ser Gly Thr Lys Thr Cys Ile Asp
 50 55 60
 Thr Lys Glu Gly Ile Leu Gln Tyr Cys Gln Glu Val Tyr Pro Glu Leu
 65 70 75 80

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Gln Ile Thr Asn Val Val Glu Ala Asn Gln Pro Val Thr Ile Gln Asn
 85 90 95
 5 Trp Cys Lys Arg Gly Arg Lys Gln Cys Lys Thr His Pro His Phe Val
 100 105 110
 Ile Pro Tyr Arg Cys Leu Val Gly Glu Phe Val Ser Asp Ala Leu Leu
 115 120 125
 10 Val Pro Asp Lys Cys Lys Phe Leu His Gln Glu Arg Met Asp Val Cys
 130 135 140
 Glu Thr His Leu His Trp His Thr Val Ala Lys Glu Thr Cys Ser Glu
 145 150 155 160
 15 Lys Ser Thr Asn Leu His Asp Tyr Gly Met Leu Leu Pro Cys Gly Ile
 165 170 175
 Asp Lys Phe Arg Gly Val Glu Phe Val Cys Cys Pro Leu Ala Glu Glu
 180 185 190
 20 Ser Asp Asn Val Asp Ser Ala Asp Ala Glu Glu Asp Asp Ser Asp Val
 195 200 205
 25 Trp Trp Gly Gly Ala Asp Thr Asp Tyr Ala Asp Gly Ser Glu Glu Lys
 210 215 220
 Val Val Glu Val Ala Glu Glu Glu Glu Val Ala Glu Val Glu Glu Glu
 225 230 235 240
 30 Glu Ala Asp Asp Asp Glu Asp Asp Glu Asp Gly Asp Glu Val Glu Glu
 245 250 255
 Glu Ala Glu Glu Pro Tyr Glu Glu Ala Arg Glu Arg Thr Thr Ser Ile
 260 265 270
 35 Ala Thr Thr Thr Thr Thr Thr Thr Glu Ser Val Glu Glu Val Val Arg
 275 280 285
 Glu Val Cys Ser Glu Gln Ala Glu Thr Gly Pro Cys Arg Ala Met Ile
 290 295 300
 40 Ser Arg Trp Tyr Phe Asp Val Thr Glu Gly Lys Cys Ala Pro Phe Phe
 305 310 315 320
 45 Tyr Gly Gly Cys Gly Gly Asn Arg Asn Asn Phe Asp Arg Glu Glu Tyr
 325 330 335
 Cys Met Ala Val Cys Gly Ser Ala Ile Pro Thr Thr Ala Ala Ser Thr
 340 345 350
 50 Pro Asp Ala Val Asp Lys Tyr Leu Glu Arg Pro Lys Pro Gln Gln Phe
 355 360 365

Phe Gly Leu Met Gly Ser Leu Thr Asn Ile Lys Thr Glu Glu Ile Ser
370 375 380

Glu Val Lys Met Asp Ala Glu Phe Arg His Asp Ser Gly Tyr Glu Val
385 390 395 400

His His Gln Lys Leu Val Phe Phe Ala Glu Asp Val Gly Ser Asn Lys
405 410 415

Gly Ala Ile Ile Gly Leu Met Val Gly Gly Val Val Ile Ala Thr Val
420 425 430

Ile Val Ile Thr Leu Val Met Leu Lys Lys Lys His Tyr Thr Ser Ile
435 440 445

His His Gly Val Val Glu Val Asp Ala Ala Val Thr Pro Glu Glu Arg
450 455 460

His Leu Ser Lys Met Gln Gln Asn Gly Tyr Glu Asn Pro Thr Tyr Lys
465 470 475 480

Phe Phe Glu Gln Met Gln Asn Tyr Gly Gly Phe Met
485 490

(2) INFORMATION FOR SEQ ID NO:3:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 3353 base pairs
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(iii) HYPOTHETICAL: NO

(iv) ANTI-SENSE: NO

(vi) ORIGINAL SOURCE:

- (A) ORGANISM: Homo sapiens

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:3:

AGTTTCCTCG GCAGCGGTAG GCGAGAGCAC GCGGAGGAGC GTGCGCGGGG CCCCGGGAGA	60
CGGCGGCGGT GGCGGCGCGG GCAGAGCAAG GACGCGGCGG ATCCCACTCG CACAGCAGCG	120
CACTCGGTGC CCCGCGCAGG GTCGCGATGC TGCCCGGTTT GGCACTGCTC CTGCTGGCCG	180
CCTGGACGGC TCGGGCGCTG GAGGTACCCA CTGATGGTAA TGCTGGCCTG CTGGCTGAAC	240

	CCCAGATTGC CATGTTCTGT GGCAGACTGA ACATGCACAT GAATGTCCAG AATGGGAAGT	300
	GGGATTGAGA TCCATCAGGG ACCAAAACCT GCATTGATAC CAAGGAAGGC ATCCTGCAGT	360
5	ATTGCCAAGA AGTCTACCCT GAACTGCAGA TCACCAATGT GGTAGAAGCC AACCAACCAG	420
	TGACCATCCA GAACTGGTGC AAGCGGGGCC GCAAGCAGTG CAAGACCCAT CCCCACCTTG	480
	TGATTCCCTA CCGCTGCTTA GTTGGTGAGT TTGTAAGTGA TGCCCTTCTC GTTCCTGACA	540
10	AGTGCAAATT CTTACACCAG GAGAGGATGG ATGTTTGCGA AACTCATCTT CACTGGCACA	600
	CCGTCGCCAA AGAGACATGC AGTGAGAAGA GTACCAACTT GCATGACTAC GGCATGTTGC	660
	TGCCCTGCGG AATTGACAAG TTCCGAGGGG TAGAGTTTGT GTGTTGCCCA CTGGCTGAAG	720
15	AAAGTGACAA TGTGGATTCT GCTGATGCGG AGGAGGATGA CTCGGATGTC TGGTGGGGCG	780
	GAGCAGACAC AGACTATGCA GATGGGAGTG AAGACAAAGT AGTAGAAGTA GCAGAGGAGG	840
	AAGAAGTGGC TGAGGTGGAA GAAGAAGAAG CCGATGATGA CGAGGACGAT GAGGATGGTG	900
20	ATGAGGTAGA GGAAGAGGCT GAGGAACCCT ACGAAGAAGC CACAGAGAGA ACCACCAGCA	960
	TTGCCACCAC CACCACCACC ACCACAGAGT CTGTGGAAGA GGTGGTTGCA GTTCCTACAA	1020
	CAGCAGCCAG TACCCCTGAT GCCGTTGACA AGTATCTCGA GACACCTGGG GATGAGAATG	1080
25	AACATGCCCA TTTCCAGAAA GCCAAAGAGA GGCTTGAGGC CAAGCACCGA GAGAGAATGT	1140
	CCCAGGTCAT GAGAGAATGG GAAGAGGCAG AACGTCAAGC AAAGAACTTG CCTAAAGCTG	1200
	ATAAGAAGGC AGTTATCCAG CATTTCCAGG AGAAAGTGGA ATCTTTGGAA CAGGAAGCAG	1260
30	CCAACGAGAG ACAGCAGCTG GTGGAGACAC ACATGGCCAG AGTGGAAGCC ATGCTCAATG	1320
	ACCGCCGCCG CCTGGCCCTG GAGAACTACA TCACCGCTCT GCAGGCTGTT CCTCCTCGGC	1380
	CTCGTCACGT GTTCAATATG CTAAAGAAGT ATGTCCGCGC AGAACAGAAG GACAGACAGC	1440
35	ACACCCATAA GCATTTGAG CATGTGCGCA TGGTGGATCC CAAGAAAGCC GCTCAGATCC	1500
	GGTCCCAGGT TATGACACAC CTCCGTGTGA TTTATGAGCG CATGAATCAG TCTCTCTCCC	1560
	TGCTCTACAA CGTGCCTGCA GTGGCCGAGG AGATTCAGGA TGAAGTTGAT GAGCTGCTTC	1620
40	AGAAAGAGCA AAAGTATTCA GATGACGTCT TGGCCAACAT GATTAGTGAA CCAAGGATCA	1680
	GTTACGGAAA CGATGCTCTC ATGCCATCTT TGACCGAAAC GAAAACCACC GTGGAGCTCC	1740
	TTCCCGTGAA TGGAGAGTTC AGCCTGGACG ATCTCCAGCC GTGGCATTCT TTTGGGGCTG	1800

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	ACTCTGTGCC AGCCAACACA GAAAACGAAG TTGAGCCTGT TGATGCCCGC CCTGCTGCCG	1860
	ACCGAGGACT GACCACTCGA CCAGGTTCTG GGTTGACAAA TATCAAGACG GAGGAGATCT	1920
5	CTGAAGTGAA GATGGATGCA GAATTCCGAC ATGACTCAGG ATATGAAGTT CATCATCAAA	1980
	AATTGGTGTT CTTTGCAGAA GATGTGGGTT CAAACAAAGG TGCAATCATT GGAATCATGG	2040
	TGGGCGGTGT TGTCATAGCG ACAGTGATCG TCATCACCTT GGTGATGCTG AAGAAGAAAC	2100
10	AGTACACATC CATTTCATCAT GGTGTGGTGG AGGTTGACGC CGCTGTCACC CCAGAGGAGC	2160
	GCCACCTGTC CAAGATGCAG CAGAACGGCT ACGAAAATCC AACCTAGAAG TTCTTTGAGC	2220
	AGATGCAGAA CTAGACCCCC GCCACAGCAG CCTCTGAAGT TGGACAGCAA AACCATTGCT	2280
15	TCACTACCCA TCGGTGTCCA TTTATAGAAT AATGTGGGAA GAAACAAACC CGTTTTATGA	2340
	TTTACTCATT ATCGCCTTTT GACAGCTGTG CTGTAACACA AGTAGATGCC TGAAC TTGAA	2400
	TTAATCCACA CATCAGTAAT GTATTCTATC TCTCTTTACA TTTTGGTCTC TATACTACAT	2460
20	TATTAATGGG TTTTGTGTAC TGTAAGAAT TTAGCTGTAT CAACTAGTG CATGAATAGA	2520
	TTCTCTCCTG ATTATTTATC ACATAGCCCC TTAGCCAGTT GTATATTATT CTTGTGGTTT	2580
	GTGACCCAAT TAAGTCCTAC TTTACATATG CTTTAAGAAT CGATGGGGGA TGCTTCATGT	2640
25	GAACGTGGGA GTTCAGCTGC TTCTCTTGCC TAAGTATTCC TTTCTGATC ACTATGCATT	2700
	TTAAAGTTAA ACATTTTTAA GTATTTTCTGAG TGCTTTAGAG AGATTTTTTT TCCATGACTG	2760
	CATTTTACTG TACAGATTGC TGCTTCTGCT ATATTTGTGA TATAGGAATT AAGAGGATAC	2820
30	ACACGTTTGT TTCTTCGTGC CTGTTTTATG TGCACACATT AGGCATTGAG ACTTCAAGCT	2880
	TTTCTTTTTT TGTCACGTA TCTTTGGGTC TTTGATAAAG AAAAGAATCC CTGTTTCATTG	2940
	TAAGCACTTT TACGGGGCGG GTGGGGAGGG GTGCTCTGCT GGTCTTCAAT TACCAAGAAT	3000
35	TCTCCAAAAC AATTTTCTGC AGGATGATTG TACAGAATCA TTGCTTATGA CATGATCGCT	3060
	TTCTACACTG TATTAGATAA ATAAATTAAA TAAATAACC CCGGGCAAGA CTTTTCTTTG	3120
	AAGGATGACT ACAGACATTA AATAATCGAA GTAATTTTGG GTGGGGAGAA GAGGCAGATT	3180
40	CAATTTTCTT TAACCACTCT GAAGTTTCAT TTATGATACA AAAGAAGATG AAAATGGAAG	3240
	TGGCAATATA AGGGGATGAG GAAGGCATGC CTGGACAAAC CCTTCTTTTA AGATGTGTCT	3300
	TCAATTTGTA TAAAATGGTG TTTTCATGTA AATAAATACA TTCTTGGAGG AGC	3353

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(2) INFORMATION FOR SEQ ID NO:4:

(i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 42 amino acids
 (B) TYPE: amino acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(iii) HYPOTHETICAL: NO

(iv) ANTI-SENSE: NO

(vi) ORIGINAL SOURCE:
 (A) ORGANISM: Homo sapiens

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:4:

Asp Ala Glu Phe Arg His Asp Ser Gly Tyr Glu Val His His Gln Lys
 1 5 10 15
 Leu Val Phe Phe Ala Glu Asp Val Gly Ser Asn Lys Gly Ala Ile Ile
 20 25 30
 Gly Leu Met Val Gly Gly Val Val Ile Ala
 35 40

(2) INFORMATION FOR SEQ ID NO:5:

(i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 11 amino acids
 (B) TYPE: amino acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(iii) HYPOTHETICAL: NO

(iv) ANTI-SENSE: NO

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:5:

Arg Pro Lys Pro Gln Gln Phe Phe Gly Leu Met
 1 5 10

(2) INFORMATION FOR SEQ ID NO:6:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 21 base pairs
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: NO

(iv) ANTI-SENSE: NO

(ix) FEATURE:

- (A) NAME/KEY: CDS
- (B) LOCATION: 1..21

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:6:

CAT CAA AAA TTG GTG TTC TTT
 His Gln Lys Leu Val Phe Phe
 1 5

21

(2) INFORMATION FOR SEQ ID NO:7:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 7 amino acids
- (B) TYPE: amino acid
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:7:

His Gln Lys Leu Val Phe Phe
 1 5

(2) INFORMATION FOR SEQ ID NO:8:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 21 base pairs
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: NO

(iv) ANTI-SENSE: NO

(ix) FEATURE:

5 (A) NAME/KEY: CDS
(B) LOCATION: 1..21

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:8:

10 CAT CAA GAG TTG GTG TTC TTT
His Gln Glu Leu Val Phe Phe
1 5

21

(2) INFORMATION FOR SEQ ID NO:9:

15 (i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 7 amino acids
(B) TYPE: amino acid
(D) TOPOLOGY: linear

20 (ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:9:

His Gln Glu Leu Val Phe Phe
1 5

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(2) INFORMATION FOR SEQ ID NO:10:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 21 base pairs
(B) TYPE: nucleic acid
30 (C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: NO

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(iv) ANTI-SENSE: NO

(ix) FEATURE:

40 (A) NAME/KEY: CDS
(B) LOCATION: 1..21

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:10:

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CAT CAA GTG TTG GTG TTC TTT
His Gln Val Leu Val Phe Phe
1 5

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(2) INFORMATION FOR SEQ ID NO:11:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 7 amino acids
(B) TYPE: amino acid
(D) TOPOLOGY: linear

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(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:11:

15

His Gln Val Leu Val Phe Phe
1 5

(2) INFORMATION FOR SEQ ID NO:12:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 21 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

20

(ii) MOLECULE TYPE: DNA (genomic)

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(iii) HYPOTHETICAL: NO

(iv) ANTI-SENSE: NO

(ix) FEATURE:

30

(A) NAME/KEY: CDS
(B) LOCATION: 1..21

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:12:

35

CAT CAA GTG TTG GTG TTC TTT
His Gln Val Leu Val Phe Phe
1 5

21

(2) INFORMATION FOR SEQ ID NO:13:

40

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 7 amino acids
(B) TYPE: amino acid
(D) TOPOLOGY: linear

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(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:13:

5 His Gln Val Leu Val Phe Phe
1 5

(2) INFORMATION FOR SEQ ID NO:14:

10 (i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 21 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

15 (ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: NO

(iv) ANTI-SENSE: NO

20 (ix) FEATURE:
(A) NAME/KEY: CDS
(B) LOCATION: 1..21

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:14:

25 CAT CAA AAA TTG GTG CCG TTT
His Gln Lys Leu Val Pro Phe
1 5

21

30 (2) INFORMATION FOR SEQ ID NO:15:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 7 amino acids
(B) TYPE: amino acid
(D) TOPOLOGY: linear

35 (ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:15:

40 His Gln Lys Leu Val Pro Phe
1 5

(2) INFORMATION FOR SEQ ID NO:16:

45 (i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 27 base pairs
(B) TYPE: nucleic acid

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(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

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(iii) HYPOTHETICAL: NO

(iv) ANTI-SENSE: NO

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(ix) FEATURE:

(A) NAME/KEY: CDS
(B) LOCATION: 1..27

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:16:

15

GTC ATA GCG ACA GTG ATC GTC ATC ACC
Val Ile Ala Thr Val Ile Val Ile Thr
1 5

27

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(2) INFORMATION FOR SEQ ID NO:17:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 9 amino acids
(B) TYPE: amino acid
(D) TOPOLOGY: linear

25

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:17:

Val Ile Ala Thr Val Ile Val Ile Thr
1 5

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(2) INFORMATION FOR SEQ ID NO:18:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 27 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

35

(ii) MOLECULE TYPE: DNA (genomic)

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(iii) HYPOTHETICAL: NO

(iv) ANTI-SENSE: NO

(ix) FEATURE:

(A) NAME/KEY: CDS
(B) LOCATION: 1..27

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(xi) SEQUENCE DESCRIPTION: SEQ ID NO:18:

GTC ATA GCG ACA GTG ATC ATC ATC ACC
Val Ile Ala Thr Val Ile Ile Ile Thr

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(2) INFORMATION FOR SEQ ID NO:19:

(i) SEQUENCE CHARACTERISTICS:

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(A) LENGTH: 9 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

15

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:19:

Val Ile Ala Thr Val Ile Ile Ile Thr
1 5

(2) INFORMATION FOR SEQ ID NO:20:

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(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 27 base pairs

(B) TYPE: nucleic acid

(C) STRANDEDNESS: single

(D) TOPOLOGY: linear

25

(ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: NO

(iv) ANTI-SENSE: NO

30

(ix) FEATURE:

(A) NAME/KEY: CDS

(B) LOCATION: 1..27

35

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:20:

GTC ATA GCG ACA GTG ATC GGC ATC ACC
Val Ile Ala Thr Val Ile Gly Ile Thr
1 5

27

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(2) INFORMATION FOR SEQ ID NO:21:

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- (i) SEQUENCE CHARACTERISTICS:
 - (A) LENGTH: 9 amino acids
 - (B) TYPE: amino acid
 - (D) TOPOLOGY: linear

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- (ii) MOLECULE TYPE: protein

- (xi) SEQUENCE DESCRIPTION: SEQ ID NO:21:

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Val Ile Ala Thr Val Ile Gly Ile Thr
 1 5

- (2) INFORMATION FOR SEQ ID NO:22:

15

- (i) SEQUENCE CHARACTERISTICS:
 - (A) LENGTH: 27 base pairs
 - (B) TYPE: nucleic acid
 - (C) STRANDEDNESS: single
 - (D) TOPOLOGY: linear

- (ii) MOLECULE TYPE: DNA (genomic)

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- (iii) HYPOTHETICAL: NO

- (iv) ANTI-SENSE: NO

25

- (ix) FEATURE:
 - (A) NAME/KEY: CDS
 - (B) LOCATION: 1..27

- (xi) SEQUENCE DESCRIPTION: SEQ ID NO:22:

30

GTC ATA GCG ACA GTG ATC TTC ATC ACC
 Val Ile Ala Thr Val Ile Phe Ile Thr
 1 5

27

- (2) INFORMATION FOR SEQ ID NO:23:

35

- (i) SEQUENCE CHARACTERISTICS:
 - (A) LENGTH: 9 amino acids
 - (B) TYPE: amino acid
 - (D) TOPOLOGY: linear

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- (ii) MOLECULE TYPE: protein

- (xi) SEQUENCE DESCRIPTION: SEQ ID NO:23:

Val Ile Ala Thr Val Ile Phe Ile Thr
 1 5

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(2) INFORMATION FOR SEQ ID NO:24:

(i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 27 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: NO

(iv) ANTI-SENSE: NO

(ix) FEATURE:

(A) NAME/KEY: CDS
 (B) LOCATION: 1..27

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:24:

CAA AAA TTG GTG TTC TTT GCG GAA GAT
 Gln Lys Leu Val Phe Phe Ala Glu Asp
 1 5

27

(2) INFORMATION FOR SEQ ID NO:25:

(i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 9 amino acids
 (B) TYPE: amino acid
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:25:

Gln Lys Leu Val Phe Phe Ala Glu Asp
 1 5

(2) INFORMATION FOR SEQ ID NO:26:

(i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 27 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: NO

(iv) ANTI-SENSE: NO

(ix) FEATURE:

(A) NAME/KEY: CDS

(B) LOCATION: 1..27

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:26:

CAA AAA TTG GTG TTC TTT GCA CAA GAT
Gln Lys Leu Val Phe Phe Ala Gln Asp
1 5

27

(2) INFORMATION FOR SEQ ID NO:27:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 9 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:27:

Gln Lys Leu Val Phe Phe Ala Gln Asp
1 5

Claims

1. A nucleic acid molecule encoding an amyloid precursor mutein, wherein the nucleic acid molecule comprises, from the 5' end to the 3' end a nucleic acid sequence encoding a marker and a nucleic acid sequence encoding amino acid up to but excluding nucleic acids encoding BAP domain.
2. A nucleic acid molecule encoding an amyloid precursor mutein, wherein the nucleic acid molecule comprises, from the 5' end to the 3' end a nucleic acid sequence encoding BAP domain and a nucleic acid sequence encoding a marker.
3. A nucleic acid molecule which comprises the nucleic acid molecule of claim 1 ligated to the nucleic acid molecule of claim 2.
4. The nucleic acid molecule of claim 3, wherein the nucleic acid molecule is a nucleic acid molecule selected from the group consisting of DNA, cDNA or RNA.
5. The nucleic acid molecule of claim 1, wherein the nucleic acid molecule is selected from the group consisting of pCLL983, pCLL935, pCLL934 and pCLL913.
6. The nucleic acid molecule of claim 2, wherein the nucleic acid molecule is selected from the group consisting of pCLL947, pCLL914, pCLL937, pCLL949 and pCLL957.
7. The nucleic acid molecule of claim 3, wherein the nucleic acid molecule is selected from the group consisting of pCLL619, pCLL620, pCLL618, pCLL964, pCLL962, pCLL989, pCLL987, pCLL990, pCLL988, pCLL600, pCLL601, pCLL602, pCLL603, pCLL604, pCLL605, pCLL606 and pCLL607.
8. A vector comprising the nucleic acid molecule of claim 1, claim 2 or claim 3.
9. A cell comprising the nucleic acid molecule of claim 1, claim 2 or claim 3.
10. A recombinant polypeptide produced by the nucleic acid molecule of claim 1, produced by the nucleic acid molecule of claim 2 or produced by the nucleic acid molecule of claim 3.

11. A method of detecting the presence of the recombinant polypeptides of claim 10 in a sample, which comprises contacting an antibody directed to the marker and the sample under suitable conditions to favor the formation of an antibody-antigen complex, and detecting the presence of any complex so formed.

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Figure 1.

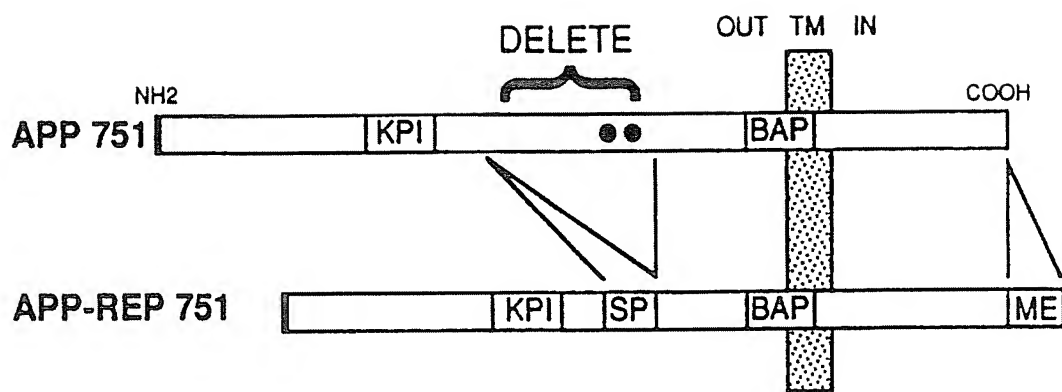


Figure 2.

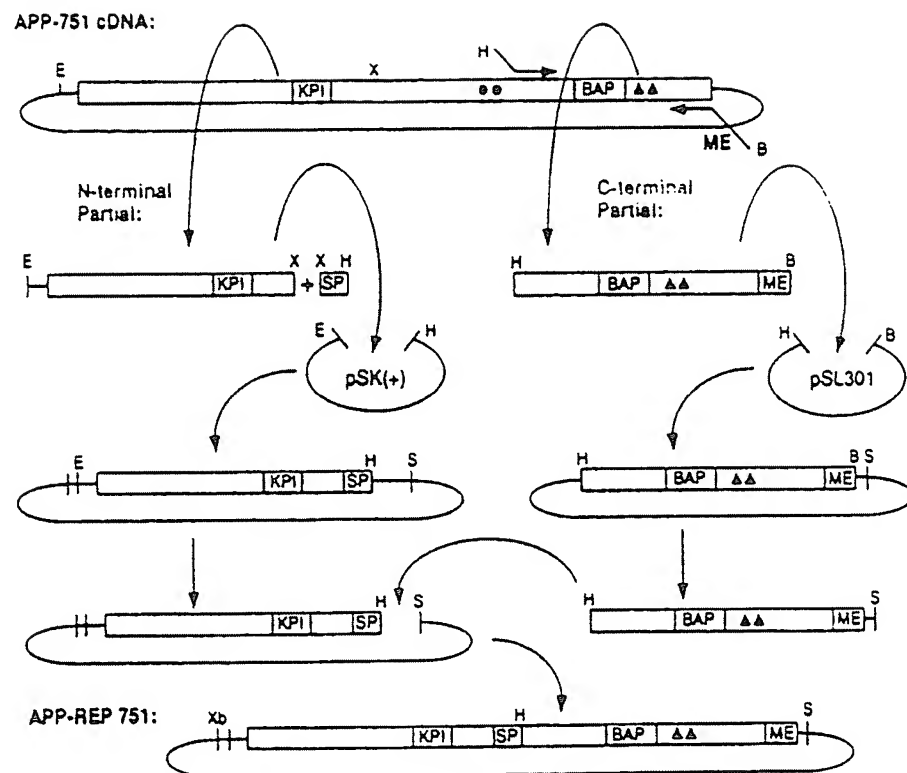


Figure 3.

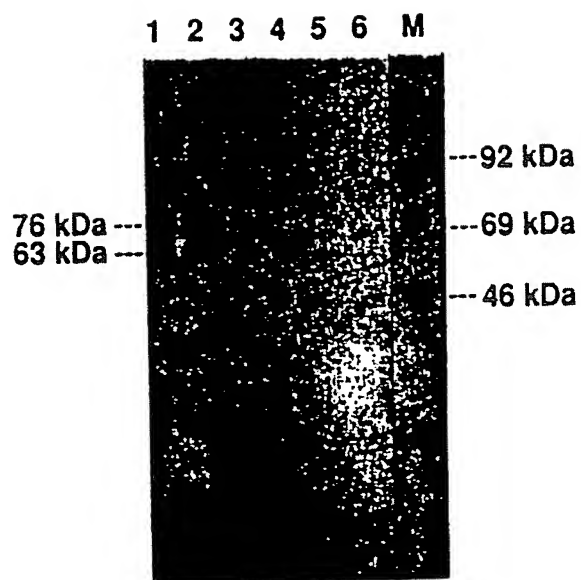


Figure 4.

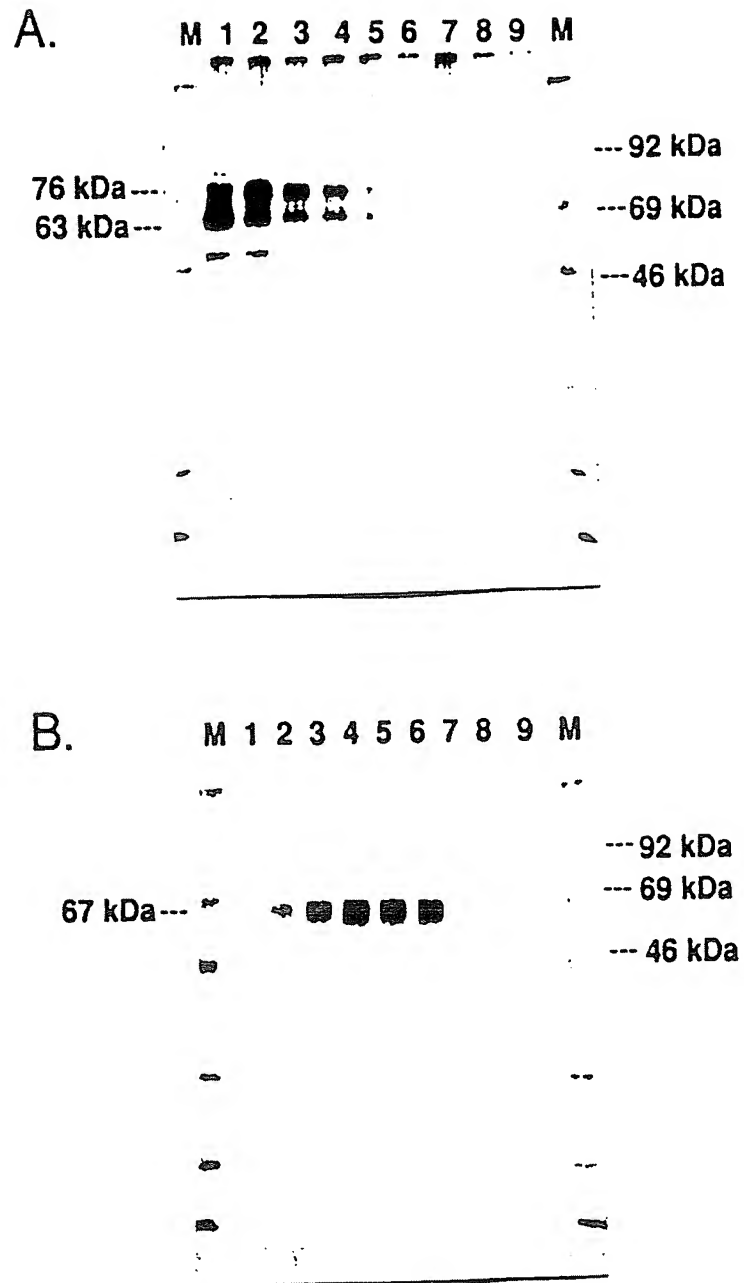


Figure 5.

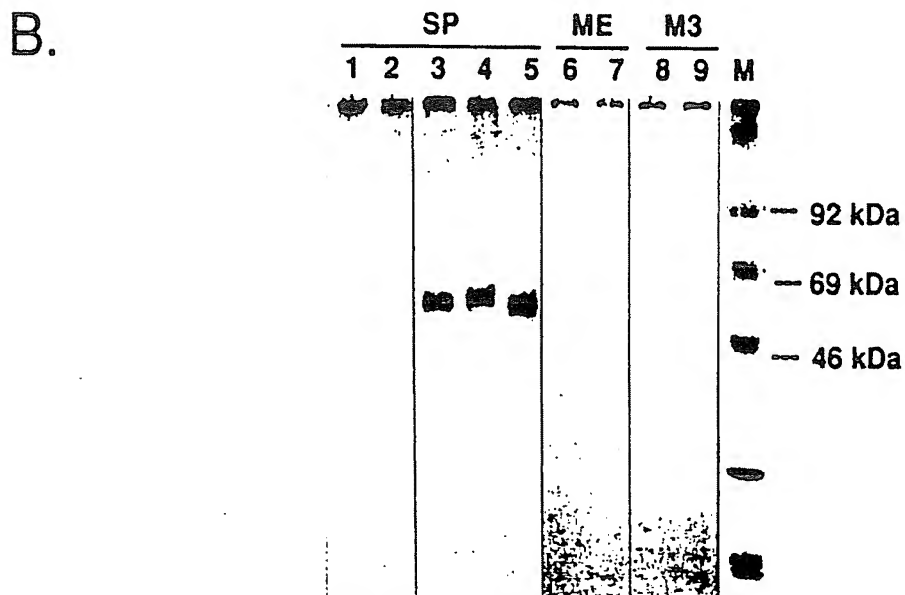
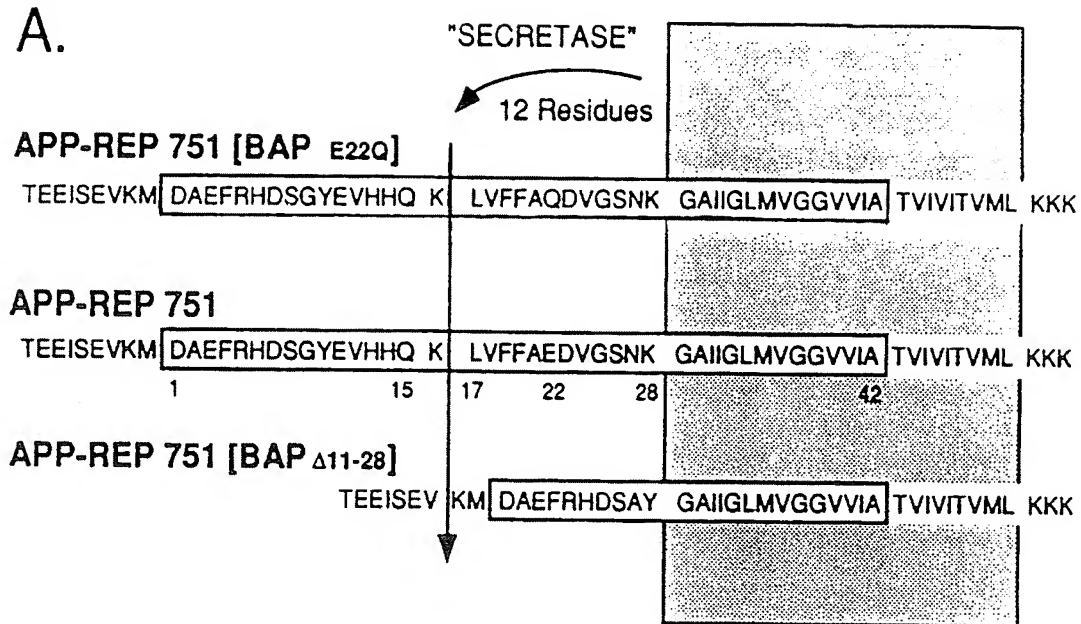
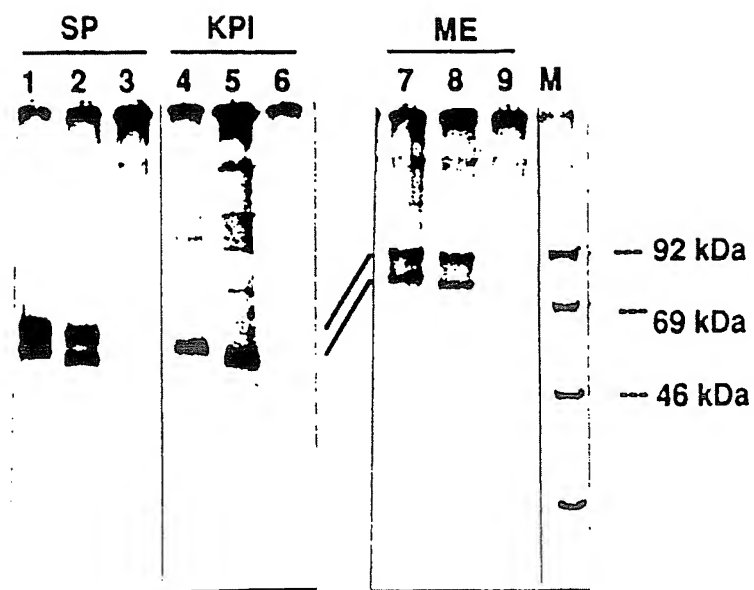


Figure 5.

C.



D.

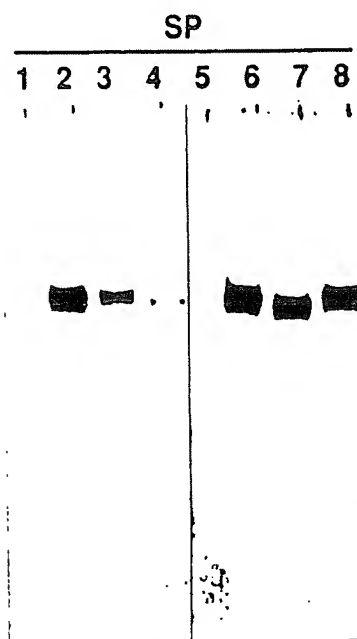


Figure 5.

E.

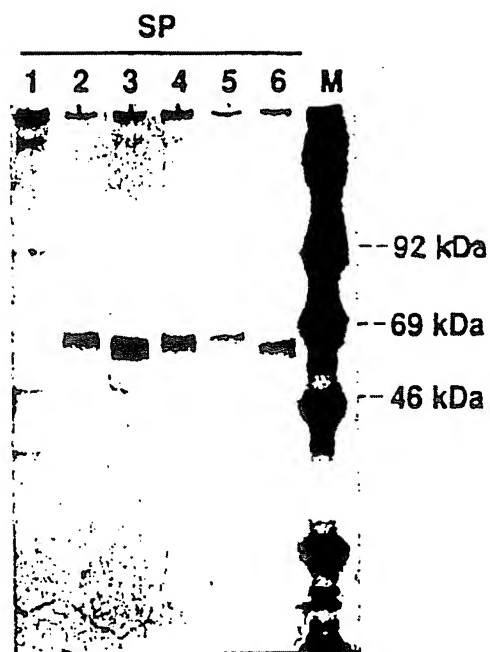


Figure 6.

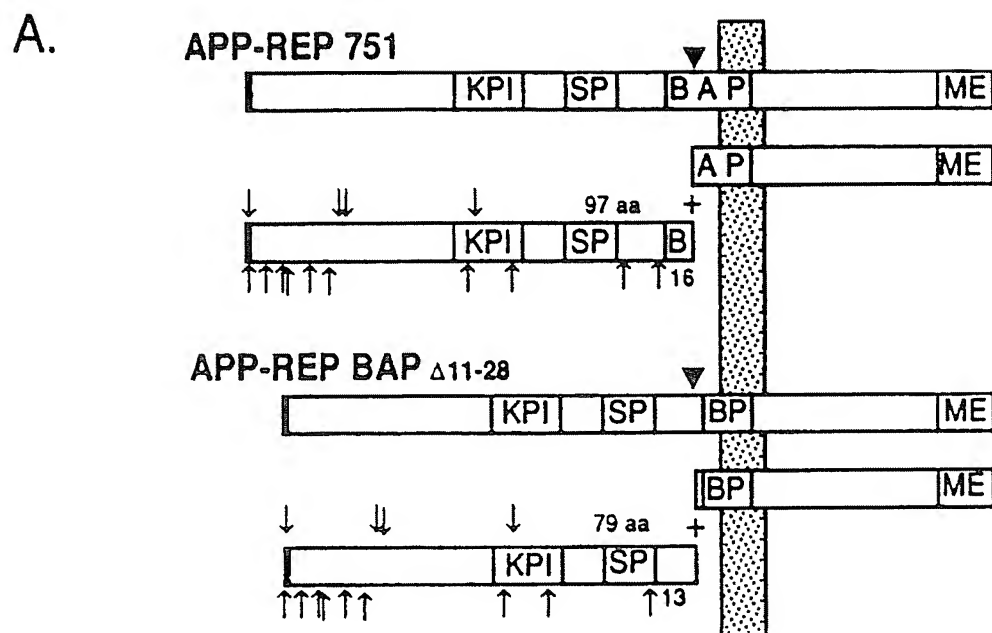
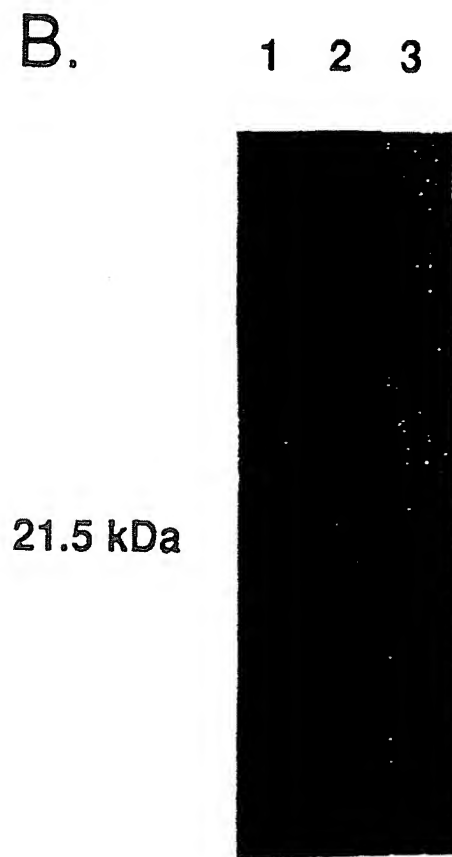


FIGURE 6.



SEQUENCE: pCLL602 (APP-REP 751 protein)
 VECTOR: pcDNA-I-neo (Invitrogen)
 pcDNA-I-neo-XS (JSJ modified polylinker to permit directional
 subcloning into XbaI-SalI sites)
 INSERT: XbaI-SalI fragment encoding APP-REP from pCLL964 16-1711
 SEQUENCE: 5' polylinker: 2-47
 HindIII-XbaI from pcDNA-I-neo-XS 2-15
 XbaI-EcoRI from pBluescript SK+ 16-47
 APP-REP 751:
 Amino-terminal partial from pCLL935): 48-1314
 5' untranslated APP cDNA (from EcoRI) 48-195
 N-terminal APP (to XhoI) 196-1273
 Substance P marker (XhoI to HindIII) 1274-1314
 Carboxy-terminal partial from pCLL947): 1314-1671
 C-terminal APP and BAP (from novel HindIII) 1314-1656
 Met-enkephalin marker (plus stop codon) 1657-1674
 3' polylinker:
 BamHI-SalI from pSL301 1674-1711
 SalI-end of sequence from pcDNA-I-neo-XS 1712-1721

10	20	30	40	50
*	*	*	*	*
AAGCTTGGGG	ATCCGCTCTA	GAAGTAGTGG	ATCCCCCGGG	CTGCAGGAAT
TTCGAACCCC	TAGGCGAGAT	CTTGATCACC	TAGGGGGCCC	GACGTCCTTA
60	70	80	90	100
*	*	*	*	*
TCGGGGGGGG	CAGCGGTAGG	CGAGAGCAGC	CGGAGGAGCG	TGCGCGGGGC
AGCCCCCCCC	GTCGCCATCC	GCTCTCGTGC	GCCTCCTCGC	ACGCGCCCCG
110	120	130	140	150
*	*	*	*	*
CCCGGGAGAC	GGCGGCGGTG	GCGGCGCGGG	CAGAGCAAGG	ACGCGGCGGA
GGGCCCTCTG	CGCCCGCCAC	CGCCGCGCCC	GTCTCGTTCC	TGCGCCGCCT
160	170	180	190	
*	*	*	*	
TCCCACTCGC	ACAGCAGCGC	ACTCGGTGCC	CCGCGCAGGG	TCGCG
AGGGTGAGCG	TGTCGTCGCG	TGAGCCACGG	GGCGCGTCCC	AGCGC
200	210	220	230	240
*	*	*	*	*
ATG CTG CCC GGT TTG GCA CTG CTC CTG CTG GCC GCC TGG ACG GCT				
TAC GAC GGG CCA AAC CGT GAC GAG GAC GAC CGG CGG ACC TGC CGA				
Met Leu Pro Gly Leu Ala Leu Leu Leu Leu Ala Ala Trp Thr Ala>				
250	260	270	280	
*	*	*	*	
CGG GCG CTG GAG GTA CCC ACT GAT GGT AAT GCT GGC CTG CTG GCT GAA				
GCC CGC GAC CTC CAT GGG TGA CTA CCA TTA CGA CCG GAC GAC CGA CTT				
Arg Ala Leu Glu Val Pro Thr Asp Gly Asn Ala Gly Leu Leu Ala Glu>				

FIGURE 7

```

290      300      310      320      330
*      *      *      *      *
CCC CAG ATT GCC ATG TTC TGT GGC AGA CTG AAC ATG CAC ATG AAT GTC
GGG GTC TAA CGG TAC AAG ACA CCG TCT GAC TTG TAC GTG TAC TTA CAG
Pro Gln Ile Ala Met Phe Cys Gly Arg Leu Asn Met His Met Asn Val>

340      350      360      370      380
*      *      *      *      *
CAG AAT GGG AAG TGG GAT TCA GAT CCA TCA GGG ACC AAA ACC TGC ATT
GTC TTA CCC TTC ACC CTA AGT CTA GGT AGT CCC TGG TTT TGG ACG TAA
Gln Asn Gly Lys Trp Asp Ser Asp Pro Ser Gly Thr Lys Thr Cys Ile>

390      400      410      420      430
*      *      *      *      *
GAT ACC AAG GAA GGC ATC CTG CAG TAT TGC CAA GAA GTC TAC CCT GAA
CTA TGG TTC CTT CCG TAG GAC GTC ATA ACG GTT CTT CAG ATG GGA CTT
Asp Thr Lys Glu Gly Ile Leu Gln Tyr Cys Gln Glu Val Tyr Pro Glu>

440      450      460      470      480
*      *      *      *      *
CTG CAG ATC ACC AAT GTG GTA GAA GCC AAC CAA CCA GTG ACC ATC CAG
GAC GTC TAG TGG TTA CAC CAT CTT CGG TTG GTT GGT CAC TGG TAG GTC
Leu Gln Ile Thr Asn Val Val Glu Ala Asn Gln Pro Val Thr Ile Gln>

490      500      510      520
*      *      *      *
AAC TGG TGC AAG CGG GGC CGC AAG CAG TGC AAG ACC CAT CCC CAC TTT
TTG ACC ACG TTC GCC CCG GCG TTC GTC ACG TTC TGG GTA GGG GTG AAA
Asn Trp Cys Lys Arg Gly Arg Lys Gln Cys Lys Thr His Pro His Phe>

530      540      550      560      570
*      *      *      *      *
GTG ATT CCC TAC CGC TGC TTA GTT GGT GAG TTT GTA AGT GAT GCC CTT
CAC TAA GGG ATG GCG ACG AAT CAA CCA CTC AAA CAT TCA CTA CGG GAA
Val Ile Pro Tyr Arg Cys Leu Val Gly Glu Phe Val Ser Asp Ala Leu>

580      590      600      610      620
*      *      *      *      *
CTC GTT CCT GAC AAG TGC AAA TTC TTA CAC CAG GAG AGG ATG GAT GTT
GAG CAA GGA CTG TTC ACG TTT AAG AAT GTG GTC CTC TCC TAC CTA CAA
Leu Val Pro Asp Lys Cys Lys Phe Leu His Gln Glu Arg Met Asp Val>

630      640      650      660      670
*      *      *      *      *
TGC GAA ACT CAT CTT CAC TGG CAC ACC GTC GCC AAA GAG ACA TGC AGT
ACG CTT TGA GTA GAA GTG ACC GTG TGG CAG CGG TTT CTC TGT ACG TCA
Cys Glu Thr His Leu His Trp His Thr Val Ala Lys Glu Thr Cys Ser>

680      690      700      710      720
*      *      *      *      *
GAG AAG AGT ACC AAC TTG CAT GAC TAC GGC ATG TTG CTG CCC TGC GGA
CTC TTC TCA TGG TTG AAC GTA CTG ATG CCG TAC AAC GAC GGG ACG CCT
Glu Lys Ser Thr Asn Leu His Asp Tyr Gly Met Leu Leu Pro Cys Gly>

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FIGURE 7
(continued)

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      730      740      750      760
      *      *      *      *
ATT GAC AAG TTC CGA GGG GTA GAG TTT GTG TGT TGC CCA CTG GCT GAA
TAA CTG TTC AAG GCT CCC CAT CTC AAA CAC ACA ACG GGT GAC CGA CTT
Ile Asp Lys Phe Arg Gly Val Glu Phe Val Cys Cys Pro Leu Ala Glu>

770      780      790      800      810
*      *      *      *      *
GAA AGT GAC AAT GTG GAT TCT GCT GAT GCG GAG GAG GAT GAC TCG GAT
CTT TCA CTG TTA CAC CTA AGA CGA CTA CGC CTC CTC CTA CTG AGC CTA
Glu Ser Asp Asn Val Asp Ser Ala Asp Ala Glu Glu Asp Asp Ser Asp>

820      830      840      850      860
*      *      *      *      *
GTC TGG TGG GGC GGA GCA GAC ACA GAC TAT GCA GAT GGG AGT GAA GAC
CAG ACC ACC CCG CCT CGT CTG TGT CTG ATA CGT CTA CCC TCA CTT CTG
Val Trp Trp Gly Gly Ala Asp Thr Asp Tyr Ala Asp Gly Ser Glu Asp>

870      880      890      900      910
*      *      *      *      *
AAA GTA GTA GAA GTA GCA GAG GAG GAA GAA GTG GCT GAG GTG GAA GAA
TTT CAT CAT CTT CAT CGT CTC CTC CTT CTT CAC CGA CTC CAC CTT CTT
Lys Val Val Glu Val Ala Glu Glu Glu Glu Val Ala Glu Val Glu Glu>

920      930      940      950      960
*      *      *      *      *
GAA GAA GCC GAT GAT GAC GAG GAC GAT GAG GAT GGT GAT GAG GTA GAG
CTT CTT CGG CTA CTA CTG CTC CTG CTA CTC CTA CCA CTA CTC CAT CTC
Glu Glu Ala Asp Asp Asp Glu Asp Asp Glu Asp Gly Asp Glu Val Glu>

970      980      990      1000
*      *      *      *
GAA GAG GCT GAG GAA CCC TAC GAA GAA GCC ACA GAG AGA ACC ACC AGC
CTT CTC CGA CTC CTT GGG ATG CTT CTT CGG TGT CTC TCT TGG TGG TCG
Glu Glu Ala Glu Glu Pro Tyr Glu Glu Ala Thr Glu Arg Thr Thr Ser>

1010      1020      1030      1040      1050
*      *      *      *      *
ATT GCC ACC ACC ACC ACC ACC ACC ACA GAG TCT GTG GAA GAG GTG GTT
TAA CGG TGG TGG TGG TGG TGG TGG TGT CTC AGA CAC CTT CTC CAC CAA
Ile Ala Thr Thr Thr Thr Thr Thr Thr Glu Ser Val Glu Glu Val Val>

1060      1070      1080      1090      1100
*      *      *      *      *
CGA GAG GTG TGC TCT GAA CAA GCC GAG ACG GGG CCG TGC CGA GCA ATG
GCT CTC CAC ACG AGA CTT GTT CGG CTC TGC CCC GGC ACG GCT CGT TAC
Arg Glu Val Cys Ser Glu Gln Ala Glu Thr Gly Pro Cys Arg Ala Met>

1110      1120      1130      1140      1150
*      *      *      *      *
ATC TCC CGC TGG TAC TTT GAT GTG ACT GAA GGG AAG TGT GCC CCA TTC
TAG AGG GCG ACC ATG AAA CTA CAC TGA CTT CCC TTC ACA CGG GGT AAG
Ile Ser Arg Trp Tyr Phe Asp Val Thr Glu Gly Lys Cys Ala Pro Phe>

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FIGURE 7
(continued)

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      1160      1170      1180      1190      1200
      *        *        *        *        *
TTT TAC GGC GGA TGT GGC GGC AAC CGG AAC AAC TTT GAC ACA GAA GAG
AAA ATG CCG CCT ACA CCG CCG TTG GCC TTG TTG AAA CTG TGT CTT CTC
Phe Tyr Gly Gly Cys Gly Gly Asn Arg Asn Asn Phe Asp Thr Glu Glu>

      1210      1220      1230      1240
      *        *        *        *
TAC TGC ATG GCC GTG TGT GGC AGC GCC ATT CCT ACA ACA GCA GCC AGT
ATG ACG TAC CCG CAC ACA CCG TCG CGG TAA GGA TGT TGT CGT CGG TCA
Tyr Cys Met Ala Val Cys Gly Ser Ala Ile Pro Thr Thr Ala Ala Ser>

1250      1260      1270      1280      1290
*        *        *        *        *
ACC CCT GAT GCC GTT GAC AAG TAT CTC GAG CGG CCC AAG CCC CAG CAG
TGG GGA CTA CGG CAA CTG TTC ATA GAG CTC GCC GGG TTC GGG GTC GTC
Thr Pro Asp Ala Val Asp Lys Tyr Leu Glu Arg Pro Lys Pro Gln Gln>

      1300      1310      1320      1330      1340
      *        *        *        *        *
TTC TTT GGC CTG ATG GGA AGC TTG ACA AAT ATC AAG ACG GAG GAG ATC
AAG AAA CCG GAC TAC CCT TCG AAC TGT TTA TAG TTC TGC CTC CTC TAG
Phe Phe Gly Leu Met Gly Ser Leu Thr Asn Ile Lys Thr Glu Glu Ile>

      1350      1360      1370      1380      1390
      *        *        *        *        *
TCT GAA GTG AAG ATG GAT GCA GAA TTC CGA CAT GAC TCA GGA TAT GAA
AGA CTT CAC TTC TAC CTA CGT CTT AAG GCT GTA CTG AGT CCT ATA CTT
Ser Glu Val Lys Met Asp Ala Glu Phe Arg His Asp Ser Gly Tyr Glu>

      1400      1410      1420      1430      1440
      *        *        *        *        *
GTT CAT CAT CAA AAA TTG GTG TTC TTT GCA GAA GAT GTG GGT TCA AAC
CAA GTA GTA GTT TTT AAC CAC AAC AAA CGT CTT CTA CAC CCA AGT TTG
Val His His Gln Lys Leu Val Phe Phe Ala Glu Asp Val Gly Ser Asn>

      1450      1460      1470      1480
      *        *        *        *
AAA GGT GCA ATC ATT GGA CTC ATG GTG GGC GGT GTT GTC ATA GCG ACA
TTT CCA CGT TAG TAA CCT GAG TAC CAC CCG CCA CAA CAG TAT CGC TGT
Lys Gly Ala Ile Ile Gly Leu Met Val Gly Gly Val Val Ile Ala Thr>

1490      1500      1510      1520      1530
*        *        *        *        *
GTG ATC GTC ATC ACC TTG GTG ATG CTG AAG AAG AAA CAG TAC ACA TCC
CAC TAG CAG TAG TGG AAC CAC TAC GAC TTC TTC TTT GTC ATG TGT AGG
Val Ile Val Ile Thr Leu Val Met Leu Lys Lys Lys Gln Tyr Thr Ser>

      1540      1550      1560      1570      1580
      *        *        *        *        *
ATT CAT CAT GGT GTG GTG GAG GTT GAC GCC GCT GTC ACC CCA GAG GAG
TAA GTA GTA CCA CAC CAC CTC CAA CTG CGG CGA CAG TGG GGT CTC CTC
Ile His His Gly Val Val Glu Val Asp Ala Ala Val Thr Pro Glu Glu>

```

FIGURE 7
(continued)

30	1600	1610	1620	1630
*	*	*	*	*
CGC CAC CTG TCC	AAG ATG CAG CAG AAC	GGC TAC GAA AAT	CCA ACC TAC	
GCG GTG GAC AGG	TTC TAC GTC GTC TTG	CCG ATG CTT TTA	GGT TGG ATG	
Arg His Leu Ser	Lys Met Gln Gln Asn	Gly Tyr Glu Asn	Pro Thr Tyr>	
1640	1650	1660	1670	1680
*	*	*	*	*
AAG TTC TTT GAG	CAG ATG CAG AAC TAT	GGG GGC TTC ATG	TAG GATCCA	
TTC AAG AAA CTC	GTC TAC GTC TTG ATA	CCC CCG AAG TAC	ATC CTAGGT	
Lys Phe Phe Glu	Gln Met Gln Asn Tyr	Gly Gly Phe Met	***	
1690	1700	1710	1720	
*	*	*	*	
TATATAGGGC	CCGGGTTAT	AATTACCTCA	GGTCGACCTA	GA
ATATATCCCG	GGCCCAATA	TTAATGGAGT	CCAGCTGGAT	CT

FIGURE 7
(continued)

Total of 12 files.
 PRMRD3>TYPE APP770.
 LOCUS HUMAFPA4 3353 bp ss-mRNA PRI 15-JUN-1989
 Human amyloid A4 mRNA, complete cds.
 ACCESSION Y00264
 KEYWORDS amyloid fibril protein; cell surface glycoprotein.
 SOURCE human (Homo sapiens).
 ORGANISM Homo sapiens
 Eukaryota; Animalia; Metazoa; Chordata; Vertebrata; Mammalia;
 Theria; Eutheria; Primates; Haplorhini; Catarrhini; Hominidae.
 REFERENCE 1 (bases 1 to 3353; enum. -146 to 3207, no zero)
 AUTHORS Kang, J., Lemaire, H.G., Unterbeck, A., Salbaum, J.M., Masters, C.L.,
 Grzeschik, K.-H., Multhaup, G., Beyreuther, K. and Mueller-Hill, B.
 TITLE The precursor of Alzheimer's disease amyloid A4 protein resembles a
 cell-surface receptor
 JOURNAL Nature 325, 733-736 (1987)
 STANDARD simple automatic
 REFERENCE 2 (bases 1 to 3353; enum. 1 to 3353)
 AUTHORS Mueller Hill, B.
 JOURNAL Unpublished (1987) Submitted to the EMBL data library.
 STANDARD simple automatic
 COMMENT *source: tissue=cortex of brain; *source: developmental
 stage=5-month-old aborted fetus;
 EMBL features not translated to GenBank features:

key	from	to	description
SITE	3080	3085	polyA signal
SITE	3089	3094	polyA signal
SITE	3331	3336	polyA signal
POLYA	3353	3353	polyA site

 FEATURES

pept	from	to/span	description
	147	2234	amyloid A4 /nomgen="APP" /map="21q21.2" /hgml_locus_uid="LG0136J"

 BASE COUNT 922 a 745 c 867 g 819 t
 ORIGIN

App770. Length: 3353 May 29, 1990 11:30 Check: 6510 ..

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1  AGTTTCCTCG GCAGCGGTAG GCGAGAGCAC GCGGAGGAGC GTGCGCGGGG
51  CCCCAGGAGA CGGCGGCGGT GGCGGCGCGG GCAGAGCAAG GACGCGGCGG
101 ATCCCACTCG CACAGCAGCG CACTCGGTGC CCCGCGCAGG GTCGCGATGC
151 TGCCCGGTTT GGCACGTGCTC CTGCTGGCCG CCTGGACGGC TCGGGCGCTG
201 GAGGTACCCA CTGATGGTAA TGCTGGCCTG CTGGCTGAAC CCCAGATTGC
251 CATGTTCTGT GGCAGACTGA ACATGCACAT GAATGTCCAG AATGGGAAGT
301 GGGATTGAGA TCCATCAGGG ACCAAAACCT GCATTGATAC CAAGGAAGGC
351 ATCCTGCAGT ATTGCCAAGA AGTCTACCCT GAACTGCAGA TCACCAATGT
401 GGTAGAAGCC AACCAACCAG TGACCATCCA GAACTGGTGC AAGCGGGGCC
451 GCAAGCAGTG CAAGACCCAT CCCCACTTTG TGATTCCCTA CCGCTGCTTA
501 GTTGGTGAGT TTGTAAGTGA TGCCCTTCTC GTTCCTGACA AGTGCAAATT
551 CTTACACCAG GAGAGGATGG ATGTTTGCGA AACTCATCTT CACTGGCACA
601 CCGTCGCCAA AGAGACATGC AGTGAGAAGA GTACCAACTT GCATGACTAC
651 GGCATGTTGC TGCCCTGCGG AATTGACAAG TTCCGAGGGG TAGAGTTTGT
701 GTGTTGCCCA CTGGCTGAAG AAAGTGACAA TGTGGATTCT GCTGATGCGG

```

FIGURE 8

751 AGGAGGATGA CTCGGAAGTC TGGTGGGGCG GAGCAGACAC AGAATATGCA
 801 GATGGGAGTG AAGACAAAGT AGTAGAAGTA GCAGAGGAGG AAGAAGTGGC
 851 TGAGGTGGAA GAAGAAGAAG CCGATGATGA CGAGGACGAT GAGGATGGTG
 901 ATGAGGTAGA GGAAGAGGCT GAGGAACCCT ACGAAGAAGC CACAGAGAGA
 951 ACCACCAGCA TTGCCACCAC CACCACCACC ACCACAGAGT CTGTGGAAGA
 1001 GGTGGTTCGA GTTCCTACAA CAGCAGCCAG TACCCCTGAT GCCGTTGACA
 1051 AGTATCTCGA GACACCTGGG GATGAGAATG AACATGCCCA TTTCCAGAAA
 1101 GCCAAAGAGA GGCTTGAGGC CAAGCACCAG GAGAGAATGT CCCAGGTCAT
 1151 GAGAGAATGG GAAGAGGCAG AACGTCAAGC AAAGAACTTG CCTAAAGCTG
 1201 ATAAGAAGGC AGTTATCCAG CATTTCCAGG AGAAAGTGGA ATCTTTGGAA
 1251 CAGGAAGCAG CCAACGAGAG ACAGCAGCTG GTGGAGACAC ACATGGCCAG
 1301 AGTGGAAGCC ATGCTCAATG ACCGCCGCCG CCTGGCCCTG GAGAACTACA
 1351 TCACCGCTCT GCAGGCTGTT CCTCCTCGGC CTCGTCACGT GTTCAATATG
 1401 CTAAAGAAGT ATGTCCGCGC AGAACAGAAG GACAGACAGC ACACCCTAAA
 1451 GCATTTGAG CATGTGCGCA TGGTGGATCC CAAGAAAGCC GCTCAGATCC
 1501 GGTCCCAGGT TATGACACAC CTCCGTGTGA TTTATGAGCG CATGAATCAG
 1551 TCTCTCTCCC TGCTCTACAA CGTGCCTGCA GTGGCCGAGG AGATTCAGGA
 1601 TGAAGTTGAT GAGCTGCTTC AGAAAGAGCA AACTATTCA GATGACGTCT
 1651 TGGCCAAACAT GATTAGTGAA CCAAGGATCA GTTACGAAA CGATGCTCTC
 1701 ATGCCATCTT TGACCGAAAC GAAAACCACC GTGGAGCTCC TTCCCGTGAA
 1751 TGGAGAGTTC AGCCTGGACG ATCTCCAGCC GTGGCATTCT TTTGGGGCTG
 1801 ACTCTGTGCC AGCCAACACA GAAAACGAAG TTGAGCCTGT TGATGCCCCG
 1851 CCTGCTGCCG ACCGAGGACT GACCACTCGA CCAGGTTCTG GGTTGACAAA
 1901 TATCAAGACG GAGGAGATCT CTGAAGTGAA GATGGATGCA GAATTCCGAC
 1951 ATGACTCAGG ATATGAAGTT CATCATCAA AATTGGTGTT CTTTGAGAAA
 2001 GATGTGGGTT CAAACAAAGG TGCAATCATT GGAATCATGG TGGGCGGTGT
 2051 TGTATAGCG ACAGTGATCG TCATCACCTT GGTGATGCTG AAGAAGAAAC
 2101 AGTACACATC CATTCATCAT GGTGTGGTGG AGGTTGACGC CGCTGTCACC
 2151 CCAGAGGAGC GCCACCTGTC CAAGATGCAG CAGAACGGCT ACGAAAATCC
 2201 AACCTACAAG TTCTTTGAGC AGATGCAGAA CT

 AGACCCCC GCCACAGCAG
 2251 CCTCTGAAGT TGGACAGCAA AACCATTGCT TCACTACCCA TCGGTGTCCA

FIGURE 8
(continued)

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2301 TTTATAGAAT AATGTGCTAA GAAACAAACC CGTTTTATGA TTTACTCATT
2351 ATCGCCTTTT GACAGCTGTG CTGTAACACA AGTAGATGCC TGA-CTTGAA
2401 TTAATCCACA CATCAGTAAT GTATTCTATC TCTCTTTACA TTTTGGTCTC
2451 TATACTACAT TATTAATGGG TTTTGTGTAC TGTAAGAAT TTAGCTGTAT
2501 CAAACTAGTG CATGAATAGA TTCTCTCCTG ATTATTTATC ACATAGCCCC
2551 TTAGCCAGTT GTATATTATT CTTGTGGTTT GTGACCCAAT TAAGTCCTAC
2601 TTTACATATG CTTTAAGAAT CGATGGGGGA TGCTTCATGT GAACGTGGGA
2651 GTTCAGCTGC TTCTCTTGCC TAAGTATTCC TTTCTGATC ACTATGCATT
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2751 TCCATGACTG CATTTTACTG TACAGATTGC TGCTTCTGCT ATATTTGTGA
2801 TATAGGAATT AAGAGGATAC ACACGTTTGT TTCTTCGTGC CTGTTTTATG
2851 TGCACACATT AGGCATTGAG ACTTCAAGCT TTTCTTTTTT TGTCCACGTA
2901 TCTTTGGGTC TTTGATAAAG AAAAGAATCC CTGTTTATTG TAAGCACTTT
2951 TACGGGGCGG GTGGGGAGGG GTGCTCTGCT GGTCTTCAAT TACCAAGAAT
3001 TCTCCAAAAC AATTTTCTGC AGGATGATTG TACAGAATCA TTGCTTATGA
3051 CATGATCGCT TTCTACACTG TATTACATAA ATAAATTAAA TAAATAAACC
3101 CCGGGCAAGA CTTTCTTTG AAGGATGACT ACAGACATTA AATAATCGAA
3151 GTAATTTTGG GTGGGGAGAA GAGGCAGATT CAATTTTCTT TAACCAGTCT
3201 GAAGTTTCAT TTATGATACA AAAGAAGATG AAAATGGAAG TGGCAATATA
3251 AGGGGATGAG GAAGGCATGC CTGGACAAAC CCTTCTTTTA AGATGTGTCT
3301 TCAATTTGTA TAAATGGTG TTTTCATGTA AATAAATACA TTCTTGAGG
3351 AGC

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European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 10 5718

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0 451 700 (MILES INC.) *Examples 6-8 and 12; Table II; Claims* ----	1-4,8-11	C12N15/12 C12N15/62 C07K15/00
X	WO-A-9 014 840 (CALIFORNIA BIOTECHNOLOGY INC.) *page 43, line 20 - page 45, line 34; Example 8; Claims* ----	1,4,8-10	C12N5/10
X	WO-A-8 803 951 (CALIFORNIA BIOTECHNOLOGY INC.) *page 41, line 1 - page 43, line 22; page 52, line 1-23; claims* ----	1,4,8-10	
A	WO-A-9 001 540 (CALIFORNIA BIOTECHNOLOGY INC.) *Example II; Claims* ----	1	
D,A	SCIENCE vol. 248, 1990, pages 492 - 495 S.S. SISODIA ET AL.; 'Evidence that beta-amyloid protein in Alzheimer's Disease is not derived by normal processing' *whole document* ----	1	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
P,X	JOURNAL OF BIOLOGICAL CHEMISTRY vol. 267, 1992, pages 25602 - 25608 S.R. SAHASRABUDHE ET AL.; 'Release of amino-terminal fragments from amyloid precursor protein reporter and mutated derivatives in cultured cells' *whole document* -----	1-11	C12N C07K
The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 16 AUGUST 1993	Examiner YEATS S.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	